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MACHINE DESIGN

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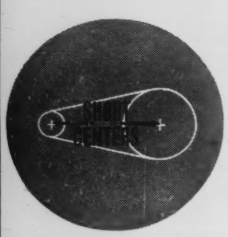

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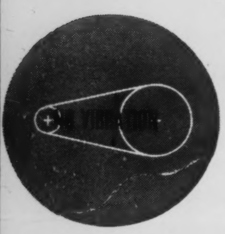

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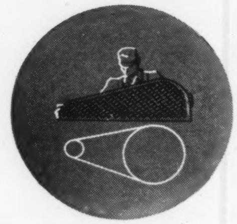

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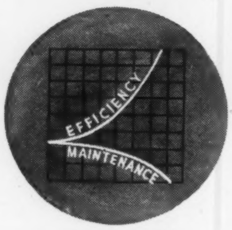

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MACHINE
THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS
DESIGN

Volume 12 MARCH 1940 Number 3

Contents

Photoelastic Analysis in Commercial Practice 31
By R. E. Orton

Scanning the Field for Ideas 36

Self-Sealed Bearings Simplify Design 38
By George Z. Griswold

Single Instrument Indicates Flight Conditions 41
By P. R. Bassett and *J. Lyman*

How Materials Affect Plain Bearing Performance 43
By Albert B. Willi

Recent Exhibitions Indicate Machine Trends 48

Die Casting Fundamentals Point Way to Extra Savings 51

Design Features in New Machines 54

Prestige of Designers Is Enhanced by Public Acclaim (Editorial) 56

Topics 28
Professional Viewpoints 57
Men of Machines 58
Noteworthy Patents 62
New Parts and Materials 66
Calendar of Meetings 76
Assets to a Bookcase 78
Manufacturers' Publications 92
Business Announcements 98
New Machines 104

For Itemized Table of Contents See Page 5

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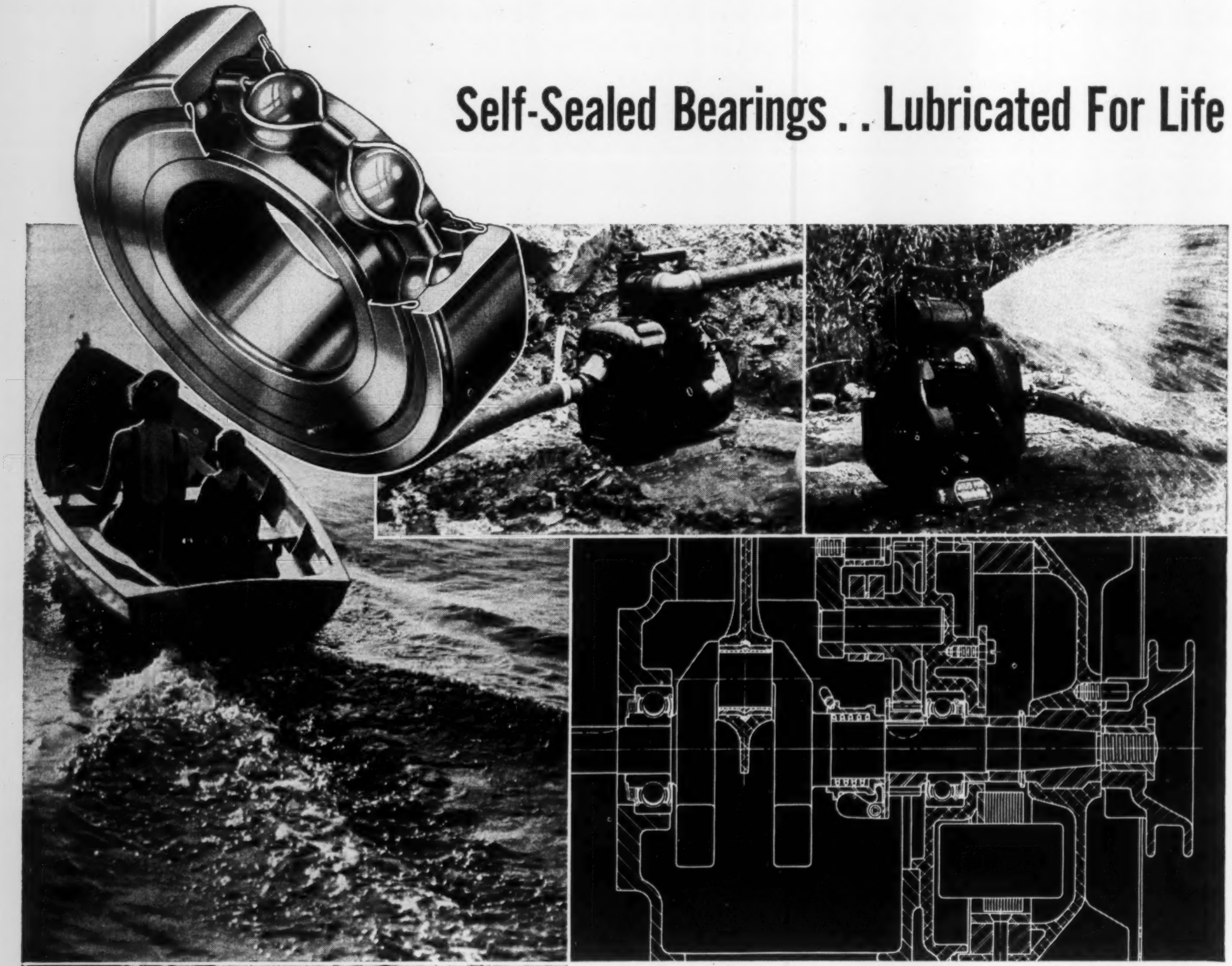
MACHINE DESIGN is published on the seventh of each month. Subscription rates: United States and possessions, Canada, Cuba and Mexico, two years $5; one year $3. Single copies 35 cents. Great Britain and other European countries, one year $5. Copyright, 1939, by The Penton Publishing Co. Acceptance under act of June 5, 1934, authorized July 20, 1934.

Self-Sealed Bearings . . Lubricated For Life



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Simplicity of design and trouble-free operation are important factors of self-sealed ball bearings invented by New Departure. Over 12 million are now in successful use.

The crankshaft installation on the Model RC Lauson Engine above has many interesting features:

Seals on the outside prevent oil leakage, also guard against entrance of dirt in the bearings. The shield on the inside of the bearings permits sufficient oil mist to enter from the crankcase to give them all the lubrication they will ever need.

Write for profusely illustrated brochure entitled *"Sealed,"* showing many cost-cutting uses of the self-sealed ball bearing, pioneered by New Departure, Division of General Motors, Bristol, Connecticut. Chicago, Detroit and San Francisco.

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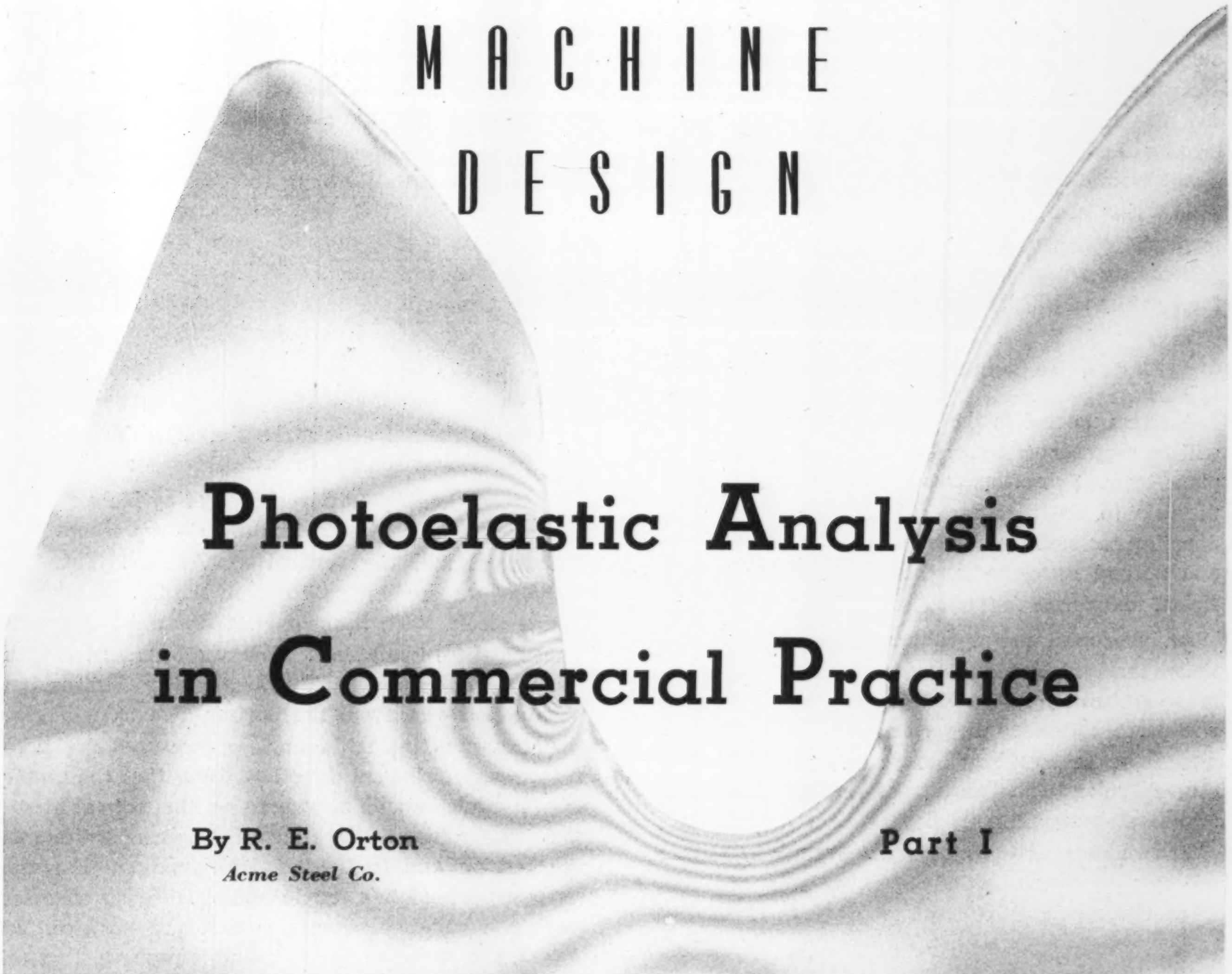
FORGED STEEL

BEARING



MACHINE DESIGN

Photoelastic Analysis in Commercial Practice

By **R. E. Orton**
Acme Steel Co.

Part I

PHOTOELASTIC technique and equipment is now such that stress determination by this method has become a practical tool for the design engineer. The cost of apparatus and model making has been reduced to the point where a formerly expensive scientific instrument has now become a thoroughly practical tool for economical use in industry. However, it has been the writer's experience that the available literature has been written from the viewpoint of the research physicist and not from that of the commercial engineer. It lacks definite instruction on technique and interpretation of results. This series of articles will attempt to supply that lack by giving sufficient information to permit one to set up apparatus, make models, interpret pictures in terms of stress, and evaluate the significance of this stress.

METHODS discussed in this article, first of a series, make photoelastic analysis an efficient and commercially useful means of solving stress problems. The author, who is chief engineer, Tool Division, Acme Steel Co., deals with the elements of photoelastic analysis as well as with applications to problems he has successfully solved

Photoelastic analysis may be defined as an optical means of determining the stress in an elastic body under a given loading. Essentially it is an experimental method of the theory of elasticity for two dimensional stress. While methods are being developed for three dimensional analysis, they are still decidedly in the laboratory stage and can hardly be considered commercial. Accordingly, this discussion will be held to plane stress. It should be pointed out that many cases of three dimensional stress may be reduced to plane stress with a superimposed third stress whose effect may be separately considered. In order satisfactorily to discuss photoelastic theory, it will be necessary first to discuss in some detail the concept of principal stresses and stress directions. A brief review will also be made of some of the physics of light as it pertains to photoelastic phenomena. The basic concepts behind the theory of elasticity will be discussed and some practical applications given in detail. No attempt will be made to derive the equations not peculiar to photoelastic phenomena, ample sources being already available.

Apparatus described here, which is sufficient for the making and annealing of models, as well as the loading and analyzing under circularly polarized monochromatic light, may be installed for less than $550. This compares with the thousands of dollars formerly considered necessary for such apparatus. A complete analysis, including picture, may be made for less than **$10.00.**

Three Stresses Show Conditions

A stress normal to the plane on which it is acting will be represented by S; and a stress parallel to the plane by v. Subscripts indicate the directions of the normals to the planes on which these stresses act. Since an inclined stress may be resolved into parallel and normal components, these components are sufficient to describe the stress acting on any given plane.

An elemental prism subjected to plane stress is shown in *Fig.* 1. It is oriented parallel and perpendicular to arbitrarily chosen X and Y axes with the dimension perpendicular to the paper equal to unity. Normal and shear stresses may act on all four of the faces perpendicular to the paper, the stresses on the other two faces being zero.

From the conditions of static equilibrium it can be shown that the shear stresses will be numerically equal, and with relative directions as shown. These three stresses, S_x, S_y, and v_{xy} completely describe conditions for the X and Y orientation of the prism. The stresses on the faces as the prism is rotated about its center will bear definite relation to the stresses S_x, S_y and v_{xy}. These three stresses, therefore, are sufficient to describe the condition of stress for any direction of the prism.

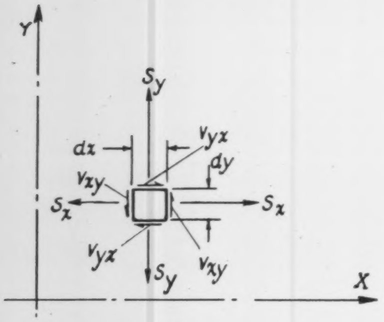


Fig. 1—Elemental prism under plane stress, showing positive directions of stress

Further, as the prism is rotated, two directions at right angles to each other will be found in which the shear stress will vanish, leaving only normal stress on the faces. These two directions are known as the *principal directions,* and these normal stresses as the *principal stresses,* noted by S_1 and S_2. Except under one particular condition to be discussed later, there will be only one set of right angle directions for which this will occur. Principal stresses are also the maximum and minimum normal stresses obtained in any direction at that point.

Relationship between principal stresses and stresses in the X and Y direction are given by

$$S_x = \frac{S_1+S_2}{2} + \frac{S_1-S_2}{2} \cos 2\alpha \ldots\ldots\ldots\ldots (1)$$

$$S_y = \frac{S_1+S_2}{2} - \frac{S_1-S_2}{2} \cos 2\alpha \ldots\ldots\ldots\ldots (2)$$

$$v_{xy} = \frac{S_1-S_2}{2} \sin 2\alpha \ldots\ldots\ldots\ldots (3)$$

$$S_x + S_y = S_1 + S_2 \ldots\ldots\ldots\ldots (4)$$

where α is the angle from the X axis to the direction of S_1, measured counterclockwise.

This relationship may be expressed by Mohr's circle diagram, *Fig.* 2. The horizontal axis represents normal stress and the vertical axis, shear. The two principal stresses are laid out on the horizontal axis and a circle, with its center on this axis, is drawn through these two points. Now, the intersection with the circle, of a radius making an angle of 2α, measured counterclockwise from the horizontal axis, will give the stresses acting at the angle α, measured clockwise from the S_1 principal direction. Note that the center of the circle can lie anywhere on the *normal stress* axis, that values to the right of the *shear stress* axis are tension and to the left, compression. For the purposes of Mohr's circle only, shearing stresses having a counterclockwise couple, are positive. In *Fig.* 1, the shear on the S_x plane is positive, that on the S_y, negative.

A study of special cases of this diagram will greatly assist in understanding the variation in stress with change of direction. If α is 45 degrees ($2\alpha = 90°$) the shear stress is a maximum, given by

$$v_m = \frac{1}{2}(S_1 - S_2) \ldots\ldots\ldots\ldots (5)$$

and the normal stresses are equal.

With no shear in any direction the circle becomes a point and the normal stress remains unchanged

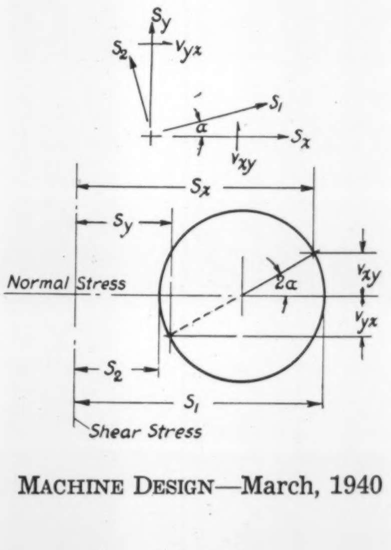


Fig. 2 — Mohr's circle Diagram, general condition.

with direction. This is the condition existing in a fluid, where no shear can be sustained. It is a substantiation of Pascal's principle that, "in a fluid the pressure is the same in all directions." From this analogy the term *hydrostatic head* or *pressure* has been applied to this condition. Note that the pressure may be either tension or compression.

The location of the center of the circle at the origin, as in *Fig.* 3, gives *pure shear*. This is the case of a shaft in pure torsion. Observe that $S_y = -S_x$ and $S_2 = -S_1 = -v_m$. We cannot have the condition of shear constant with change of direction, such as we have for normal stress.

Conditions when one principal stress is equal to zero are shown in *Fig.* 4. This is the case in a simple tension test. Stress systems for two different loadings may not be added without regard to direction. It can be shown, however, that a stress system may be considered as consisting of a hydrostatic head, the distance to the center of Mohr's circle, and a pure shear, the circle itself. The hydrostatic heads may then be algebraically added, and the pure shears vectorially, as shown in *Fig.* 5, giving the resultant hydrostatic head and resultant shear circle for the combined system. θ is the angle between the two maximum principal stresses, β the angle of the resultant system. This method is of value where it is necessary to apply the loads separately to the model.

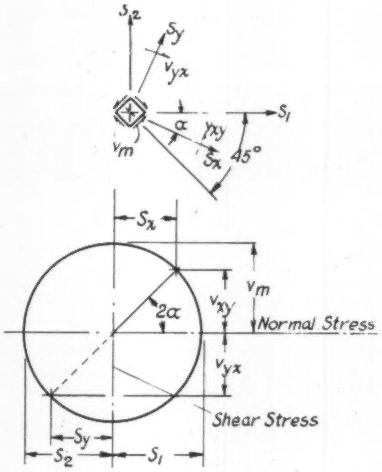


Fig. 3 — Mohr's circle diagram for pure shear. Positive directions of angle are shown

Light is considered to be transverse wave motions similar to water waves except the motion is in all directions. Each wave form is a sine curve and, as illustrated in *Fig.* 6, may be represented by a rotating vector the length of which is equal to the wave amplitude. The position of any point along the wave is given by the angle, at that time, of the rotating vector from a given reference line. This angle is the *phase* angle, and has been denoted as γ in *Fig.* 6.

Intensity of the light is proportional to the square of the amplitude. The color is a characteristic of the frequency and does not change regardless how the light is reflected or transmitted. The colors of the spectrum are pure colors corresponding to the various frequencies from red, a low frequency, to violet, a high frequency. All other colors consist of mixtures of these pure colors in various proportions. White light is a mixture of all colors in a definite proportion, and any color may be obtained from white light by filtering out the undesired colors.

While the frequency remains unvaried the velocity changes with the material being traversed. Since the velocity is equal to the product of the wave length and the frequency, the wave length also changes. Where not otherwise specified references are to the velocity and wave length in a vacuum or in air, which is but slightly different. It is customary to describe the frequency by giving the wave length in angstrom units, denoted *A.U.* or *A°*. This unit is equal to 10^{-10} part of a meter. The visible spectrum ranges from 3800 (deep violet) to 7700 (deep red) *A.U.*

Ray Components Provide Interference

A *ray* of light has been defined as the emanation in one direction only from a point source. *Relevant* rays are from the same point and *irrelevant* from different points. It is a peculiar characteristic of light that interference between irrelevant rays may not occur. If this were not so two light sources would interfere with each other and perhaps produce darkness, or a "beat" note as in sound. Instead of this the light intensities of irrelevant rays, however, are added directly.

Interference may occur between relevant rays. Since relevant rays come from the same source they will have the same frequency. Interference of two sine waves of the same frequency will produce a new sine wave of the same frequency. Therefore, the frequency of interfering light waves remains the same. The amplitude of the new wave will be equal to the vectoral composition of the wave vectors, having regard to their phase angles. This is illustrated in *Fig.* 7 where γ_1 is the phase angle difference between the two waves. The above is for vibrations lying in the same plane. Interference between components lying in different planes will produce a space wave, such as a helix etc.

Association of relevant rays in order to secure interference phenomena is to date only a theoretical possibility. The method actually used is to split a

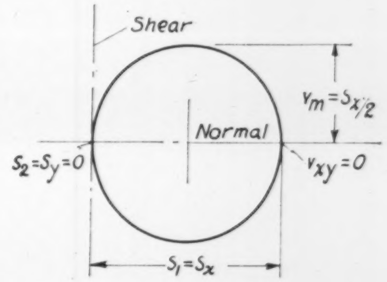


Fig. 4—Circle diagram for simple tension

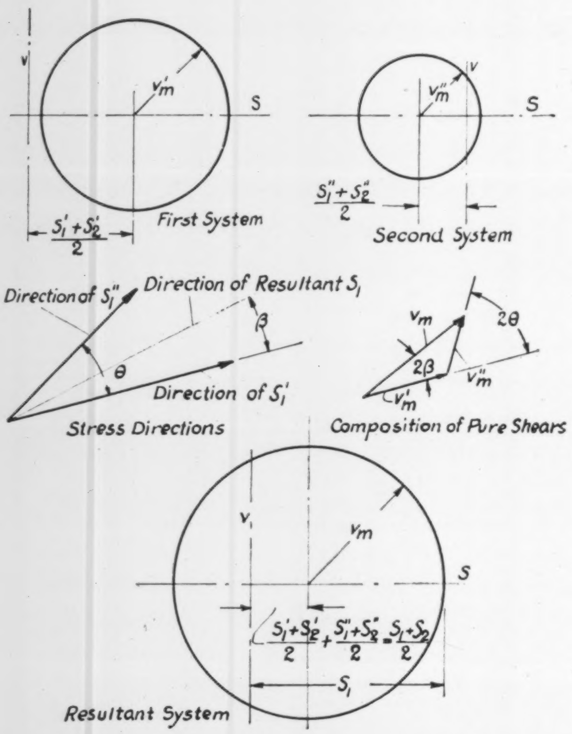


Fig. 5—Composition of two stress systems showing method of developing resultant system

ray into two components and secure interference between these components. A good deal of the apparatus necessary for photoelastic analysis is required to secure this spliting and orient the components into the same plane.

All the rays of a beam of light may be made to vibrate parallel to one plane, similarly to waves on water. When light is so organized it is termed *plane polarized.* The light emanating from most sources is unpolarized.

In general, light is transmitted through isotropic media without change in its characteristics, except for velocity and wave length, and these are regained upon emergence. Many crystals however, have the property of polarizing light along two right angle directions. Each ray is resolved into its components upon the polarizing planes. The velocity of the light in these two planes is different, so that the ray components emerge out of phase with each other.

Methods for Polarizing Light

Some of these crystals, such as tourmaline, have the property of absorbing one of the components, the light emerging polarized entirely in the other plane. Such crystals are termed *polarizing filters.* They constitute one means of securing a plane polarized beam. Since plane polarized light is required for photoelastic analysis it is interesting to consider some of the other means by which it may be obtained.

Another way is by the use of a Nicol prism, made from one of the doubly polarizing crystals by cutting it along a certain plane and cementing it together in such a way that one of the polarized light beams is reflected to one side and absorbed, the other transmitted through. These prisms, usually made from Iceland spar, are expensive due to the difficulty of securing satisfactory specimens and the skill required to make.

A third means takes advantage of a reflection phenomenon. When a beam of light is incident at the proper angle on a plate of glass it polarizes in two right angle planes. Part of the light in one plane is reflected, the remainder is transmitted with the light in the other plane, giving a reflected polarized beam. This means has the objection that the polarized beam is traveling at an angle to the original beam, causing difficulty in manipulation of the apparatus.

A fourth method uses the transmitted light of the third, sending it through a stack of plates and thereby filtering out more and more of the reflected beam until there is left a beam of light essentially polarized in the other direction. The objection here is the considerable loss of light due to absorption. These last two methods have however, in the past, proved useful for large field polariscopes.

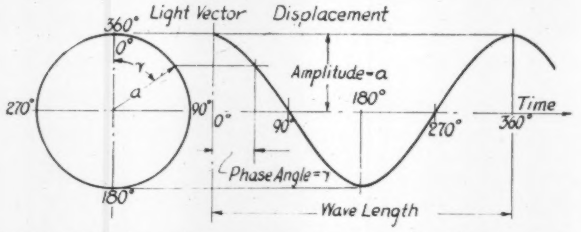


Fig. 6—Vectoral representation of a light wave. Phase angle, amplitude and wave are indicated

Use of Polaroid disks comprise a fifth method. These disks consist of a transparent plate to which is bonded, in a thin film, a synthetically made single crystal of a polarizing filter material. They have made polarized light available at a fraction of the cost of Nicol prisms, and of better quality than reflection or transmission methods. They are an important factor in making the photoelastic a commercial method of analysis.

Such a disk polarizes light in two right angle planes and absorbs the component in one. In addition there is a transmission loss of about 10 per cent, the emergent light having therefore about 45 per cent of the intensity of the incident. If the beam is now passed through a second disk with its axis parallel to the first, the only additional loss will be that of transmission, the light having about 40 per cent of its original intensity. If the axis is crossed, however, there will be again a component in the absorbing direction, the light being reduced an amount depending upon the angle between the axes. If a right angle, all of the light will be suppressed.

Circularly polarized light is also used in photoelastic analysis. The interference of two perpendicular components of equal amplitude, a quarter wave out of phase, will give a wave of constant displacement and uniformly varying direction of polarization. The wave shape will be a helix. If a doubly polarizing crystal were the right thickness, one ray would emerge a quarter wave out of phase with the other. A light beam, polarized at 45 degrees to the crystal axes, would then emerge with its components meeting the above requirements, producing circularly polarized light. The requirements can be met, however, for only one wave length and these prepared crystals, known as *quarter-wave* plates, are limited to the monochromatic light for which they have been made.

Change in Velocity Is Proportional to Stress

Certain non-crystalline transparent materials, such as glass and most plastics, when under plane stress act the same as a doubly polarizing crystal, polarizing in the principal directions. Moreover, the light velocity changes from the unstressed velocity in direct proportion to the stress. If the rays are perpendicular to the plane of stress each component will have, throughout its path, a constant value and direction of stress, and therefore constant velocity and plane of polarization. The components then, will emerge out of phase with each other an amount proportional to the principal stress difference and the thickness of the material.

In most materials, tension increases the velocity and compression decreases it. In either case the components emerge, from a plate of uniform thickness, out of phase with each other, *retarded* an amount proportional to the algebraic difference in the principal stresses. A polarizing disk placed to intercept these components will rotate them into one plane with a resultant wave as illustrated in *Fig.* 7. If further, the light supplied to this plate be plane polarized, the amplitude of the components and therefore of the resultant wave will remain fixed with the stress. As described later, this permits of measuring the retardation.

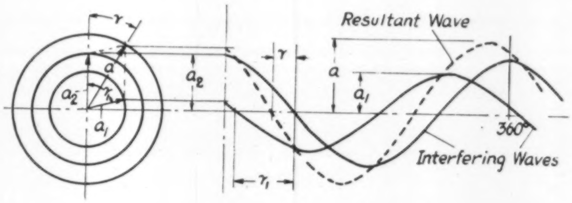
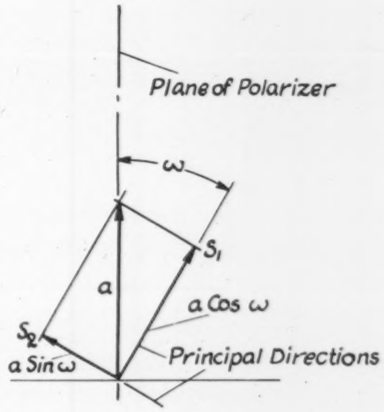


Fig. 7—Interference between two out-of-phase light waves showing resultant wave

The simplest photoelastic apparatus consists of two polarizing disks supplied with a beam of parallel rays of monochromatic light and a device for holding and loading a model of the above material in a position perpendicular to the beam of light, between the disks. The first disk is the *polarizer;* the second, the *analyzer*.

A ray of light, after passing through a vertically set polarizer, will be polarized in the vertical plane. At the model, the ray is split into components polarized in the principal directions. This is represented vectorially in *Fig.* 8, where *a* is the amplitude before entering the model and ω is the inclination of the principal directions. Assuming the stress is different in the two directions the components will also be out of phase with each other. They now pass through the analyzer, set at right angles to the polarizer, and produce components on the horizontal plane, as shown in *Fig.* 9. Each of the resultant components now lie in the same plane and have the same amplitude. While the amplitude varies with the principal direction, the variation is the same for both components.

Fig. 8 — Plane polarized ray after leaving stressed model. View is perpendicular to ray direction



Assume the stress difference between S_1 and S_2 is reduced to zero, bringing the components into phase with each other. One component has been laid down to the right and the other to the left so that, since they have equal amplitude, they completely cancel each other, leaving total darkness. Introduction of a small stress difference will move them a fraction of a wave length out of phase. The composition of these out of phase waves, similarly as in *Fig.* 7, will result in a new wave of the same frequency but of small amplitude; therefore the darkness lightens slightly. As the stress difference is increased the

(*Continued on Page* 84)

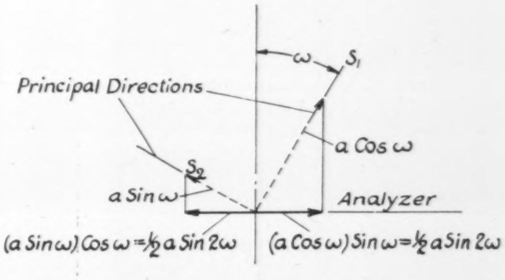
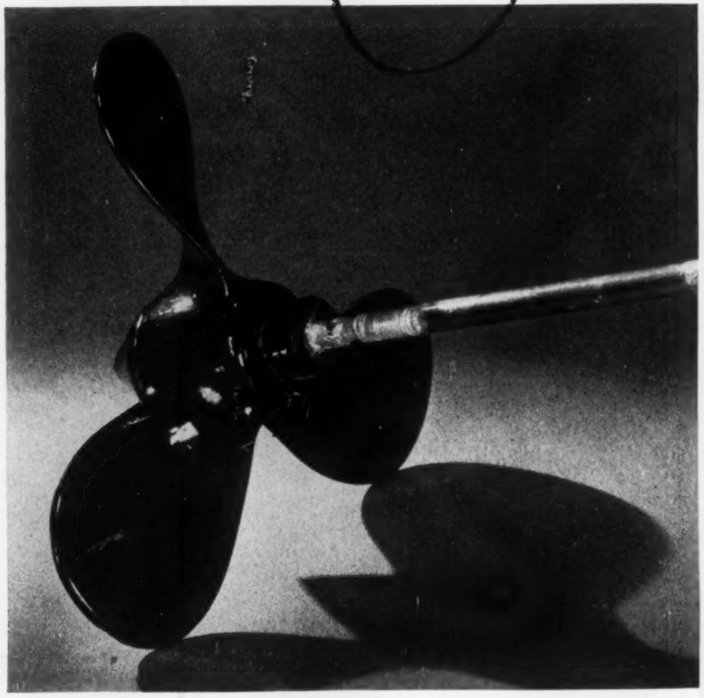

ω
S_1
Principal Directions
a Cos ω
S_2
a Sin ω
Analyzer
$(a \, Sin \, ω) \, Cos \, ω = \frac{1}{2} a \, Sin \, 2ω$
$(a \, Cos \, ω) \, Sin \, ω = \frac{1}{2} a \, Sin \, 2ω$

Fig. 9—Ray after leaving analyzer. View is on plane at right angles to the ray direction

Scanning the Field FOR IDEAS

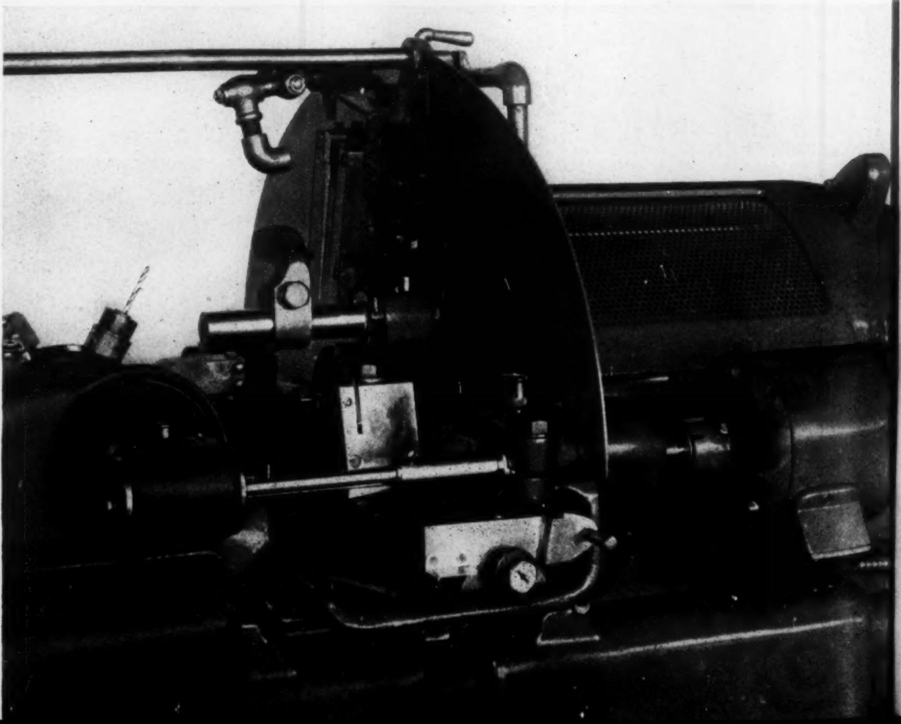
Resistant to corrosion and abrasion, the varnish used on this propeller test was unaffected although subjected to the equivalent of four year service. Salt water, abrasive particles and electrolytic action had no apparent effect on the heat-reactive bakelite resin varnish used. Original luster of the varnish remains although the shaft is badly corroded.

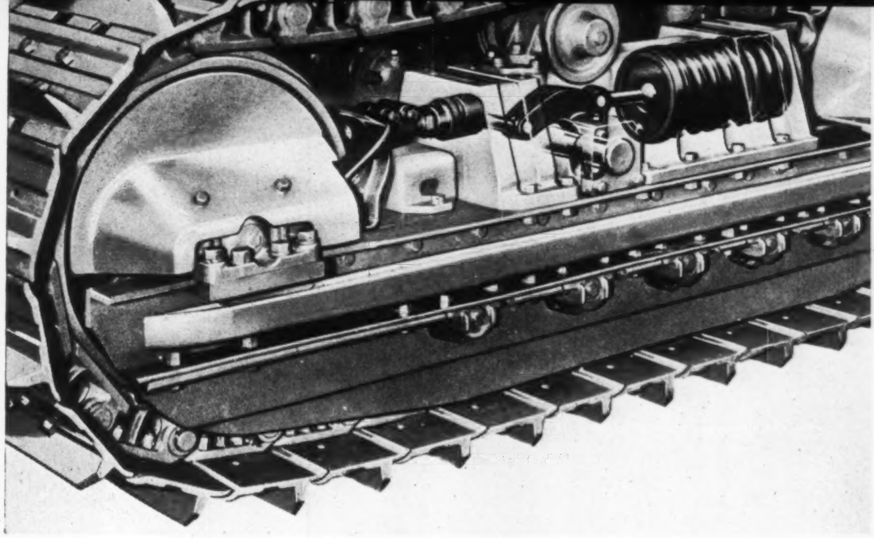
During test, the propeller was operated at five times normal speed in a tank filled with sea water and abrasive particles. In addition a constant voltage was impressed on the shaft end. Three shafts were worn out during the test. Propeller would have been entirely decomposed had any coating failure occurred



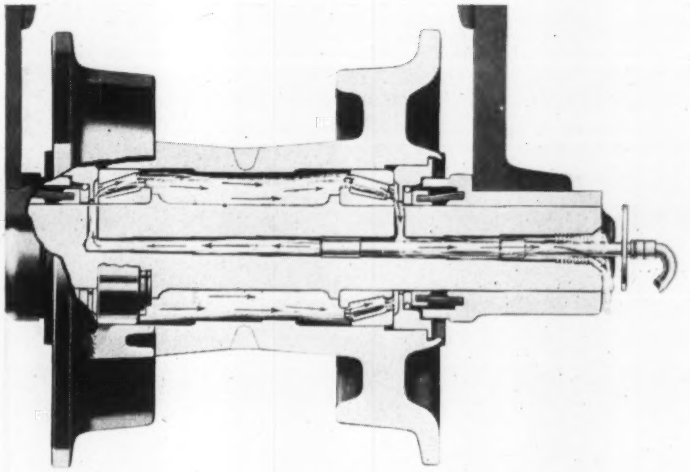
Attachment drives for cross drilling and turret drilling on automatic screw machines as shown at right provide a direct and simple means of operating these mechanisms, eliminating any difficulty encountered with short belts from auxiliary countershafts.

Motor for attachment, developed by Brown and Sharpe Mfg. Co., is mounted at rear of machine. Drive is transmitted through a flexible coupling to right-angle gearing and thence by a short shaft assembly to the attachment. Design permits full freedom in positioning and feeding





Bell crank reduces pressure on track release mechanism shown in the Allis-Chalmers Tractor at left. With this design the pressure exerted on the idler is its maximum when compression starts. When the idler moves back, the lever arm of the front link increases while that of the rear link decreases. This idea overcomes the difficulty in compressing an ordinary spring which requires more and more force the further compressed. Thus when foreign objects lodge in the track, the additional force from the spring increases the strain whereas this design reduces the spring load.

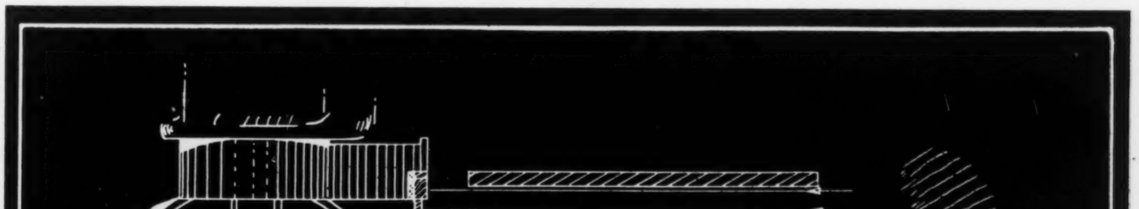


Truck wheels for this tractor, also shown at left, require lubrication only at intervals of 200 working hours in comparison with 10-hour intervals on previous designs. This long interval is accomplished by a combination of roller bearings and two glass-smooth steel rings held together by a ring of compressed synthetic rubber. One ring is stationary, the other turns with the wheel. Illustration shows how new lubricant flushes out old through large counterbore. Arrows indicate flow

Compensating bimetallic ring surrounding a heat-responsive bimetallic coil in the burner control shown below corrects for any ambient temperature change, thus preventing the control from operating unless required by burner conditions. Developed by the Mercoid Corp., light rays from burner are directed on the coil by a concave reflector. Because the bimetallic coil is opaque, the light rays are transmuted into heat. As long as burner is operating, the coil remains expanded and holds a contact arm in a mercury pool. A fixed contact in this pool completes the burner control circuit.

As ambient temperature changes occur, all parts of the unit are affected in such a way as to cause no movement of the contact arm. If the temperature is rising the small coil moves accordingly but the outer bimetallic ring is also affected and moves in an opposite direction so that no change in position results.

In event of flame failure, no energizing light waves are concentrated on the coil and it adjusts itself to the ambient, drawing the contact arm from the pool of mercury thus opening the circuit and stopping fuel supply



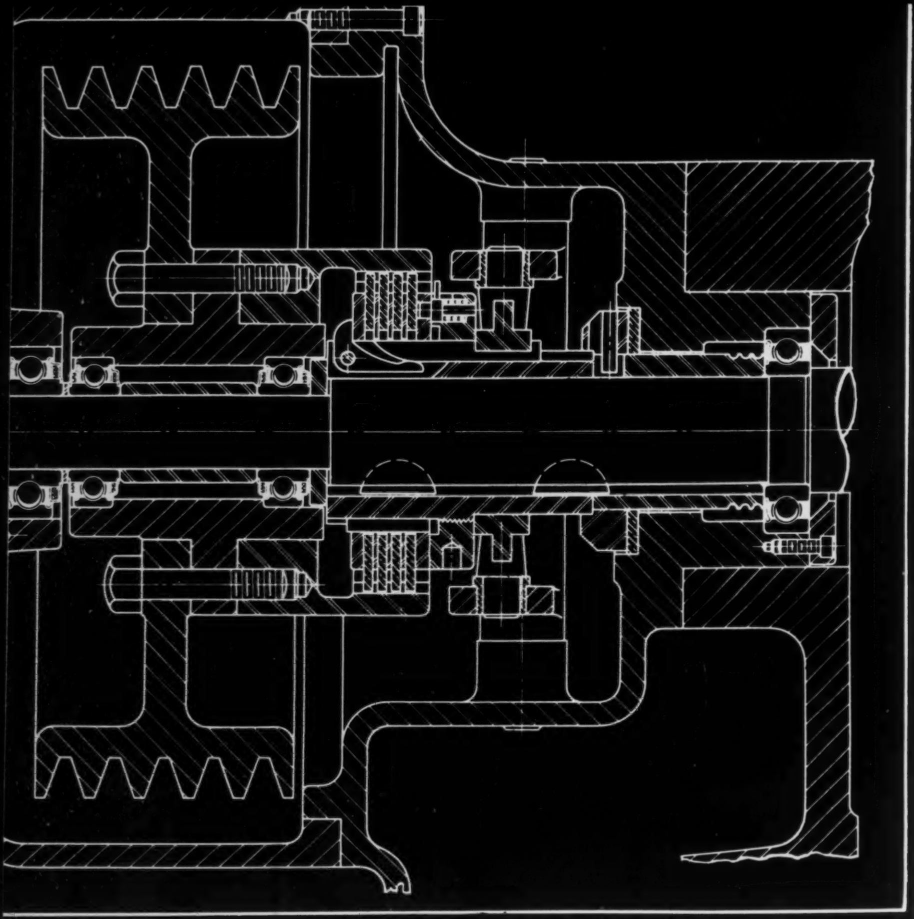


Fig. 1—Application of three sealed bearings in the drive pulley and clutch mounting of a lathe headstock. Extensive maintenance would be costly

Self-Sealed

By George Z. Griswold

DEMAND for better sealing of bearings has led within the past decade to the development of antifriction bearings equipped with built-in seals, since it was logical that dirt could be excluded better and lubricant retained more efficiently if the bearing were sealed during its manufacture. Extensive research finally culminated in successful designs.

Thus far these self-sealed units have been limited to ball bearings, although needle or quill bearings and certain other types of roller bearings may be considered inherently self-sealing by reason of their construction. In addition, it is quite possible that roller bearings will be developed with built-in seals. It is true, in general, that most ball bearings with built-in seals have been of the radial type. This article will discuss how sealed antifriction bearings fit into the design picture and will cite their advantages, disadvantages, and other points relating to their most efficient application.

In common with other types of antifriction bearings, self-sealed units are notable for their ability to simplify certain phases of design, particularly those pertaining to the mounting of the bearings. They are solving many problems which previously could not be handled as easily or as well.

The self-sealed bearing finds its most efficacious use in machines where the bearing must be thoroughly protected on one or both sides, or where it is essential that the grease be retained, without the use of separate, individual shaft seals. In the best types of integrally sealed bearings, future lubrication is usually unnecessary.

Since lubrication other than that already injected within the seal may not be needed, the lubrication system of a machine will be less of a problem. Lubricant holes or fixtures, together with drilling and tapping, may be disregarded. These factors permit easier attainment of smooth machine exteriors, in line with modern trends.

The designer, while wishing to plan a machine capable of as economical manufacture as possible, also tries to produce one which will require a minimum of maintenance by the ultimate user. Costs of further lubricants or lubricating time may be eliminated when bearings having built-in seals are specified.

Maintenance May Be Reduced

At the same time, the maintenance necessitated by accumulation of dirt or by evidence of wear will also be reduced. Since sealed bearings may be preloaded like other types, they do not call for further adjustments. Finally, where they are operating in the presence of products like textiles, foodstuffs, or other organic compounds, they offer considerable protection from spoilage caused by oil spots.

Fig. 1, the drive pulley and clutch mounting of a

Bearings Simplify Design

lathe headstock, illustrates the application of three sealed bearings in a case where extensive maintenance would be a costly matter. At the same time, oil is prevented from entering and deteriorating the clutch and V-belt pulley compartment. Examination of *Fig.* 4, where two sealed bearings are used in a motor, will reveal how design was simplified, machining kept to a minimum.

To show how bearings with built-in seals are not limited to standard types but may be varied to meet particular conditions, *Fig.* 2 illustrates a special purpose bearing for an automotive fan and water pump. A liberal oil reservoir is provided between the ball rows. *Fig.* 3 shows how sealed bearings aid compact design. In this case of a grooved idler the double row bearing forms an integral part of the grooved section. Another type of bearing with individual shaft seals undoubtedly could have been used here, but probably not as satisfactorily.

As with all machine parts, self-sealed bearings cannot be used indiscriminately without regard to types and their suitability for various operating conditions, such as high speeds and elevated temperatures. Almost invariably bearing capacity ratings will decrease as speed increases. The frequency with which balls

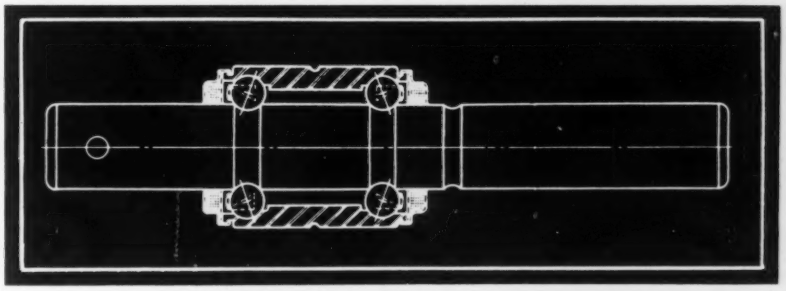


Fig. 2—Above—In this special purpose bearing for an automotive fan and water pump, a liberal oil reservoir is provided between ball rows

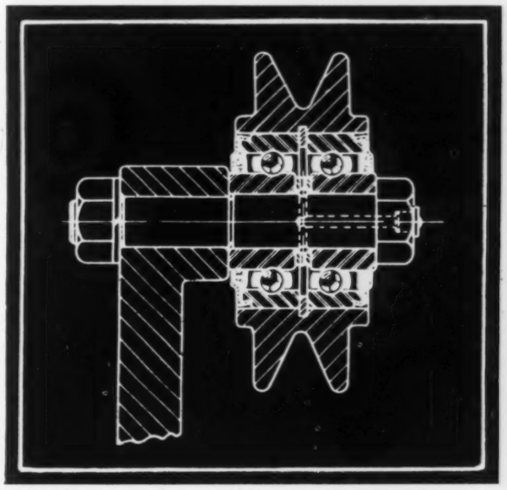


Fig. 3—Above—The double row bearing forms an integral part of this grooved idler, showing how design is facilitated

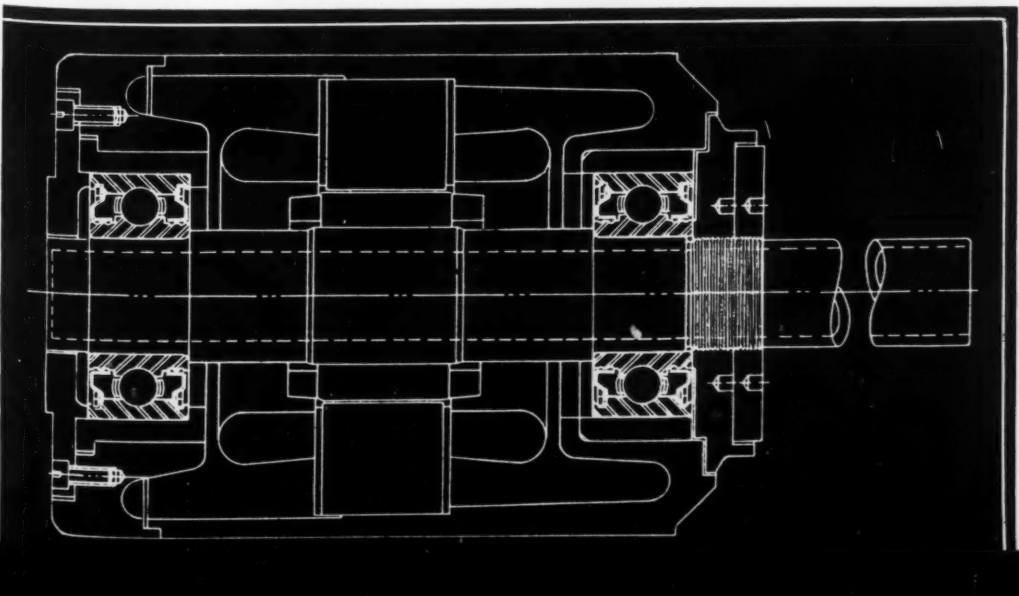


Fig. 4—Left—Design is simplified and machining kept to a minimum when self-sealed bearings are used in this motor

are loaded and again unloaded has a direct effect on the expected life of the assembly and hence load ratings are adjusted accordingly. Great care should be given the installation or service factor when bearings are chosen, particularly from catalogs. When elements such as alignment or deflection of parts, steady or shock loads, and housing and shaft diameters, enter the bearing picture to a disproportionate extent, consultation with a reputable manufacturer is advisable while the machine is still in the layout stage. Later trouble will be eliminated.

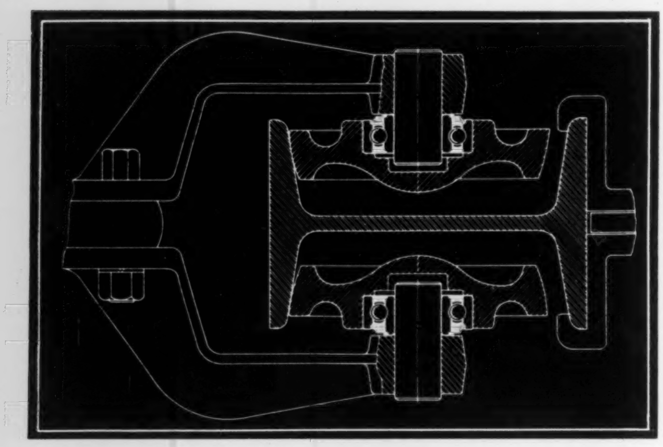


Fig. 5—Parts of this trolley conveyor are plain and were economically produced, use of the sealed bearing eliminating many machining operations. Fig. 6—Below—A photograph of half of the assembly shown above. Dirty conditions of operation are clearly evident

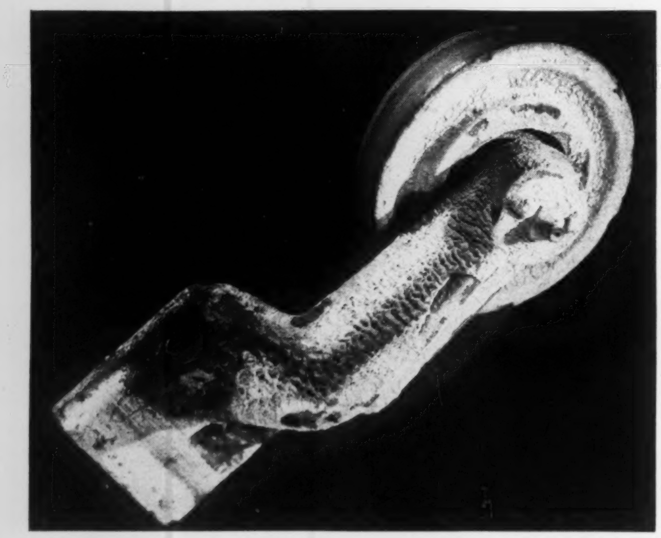
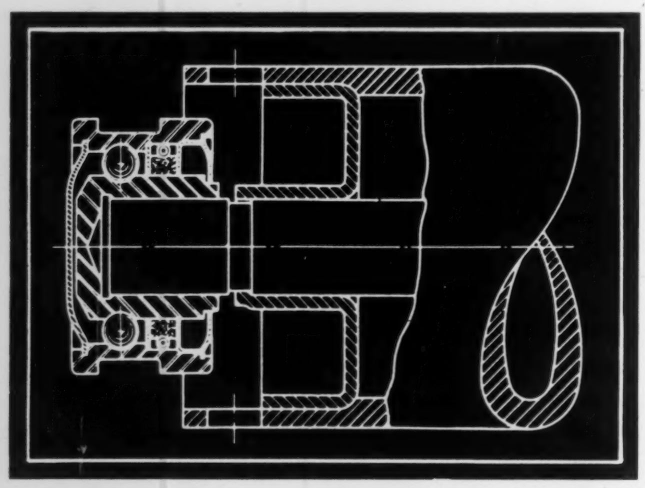


Fig. 7—Below—Even need for a shaft shoulder was eliminated in this portable coal mining conveyor roll through use of the special self-sealed bearing



As a point to be borne in mind on present limitations of self-sealed bearings, it is generally true that such a bearing with wide, snugly fitted seals, should not be expected to operate at very high speeds, particularly when very dirty conditions exist. *Figs.* 5 and 6, showing two views of self-sealed bearings on part of a conveyor system, offer a case in point.

Manufacture Made Easier

Simplicity in design and manufacture of the conveyor trolley is evident by the absence of threading for locknuts, or of drilling or tapping. The parts are consequently of plain form, easily and economically produced. An idea of the conditions of operation may be gained from the photograph, which shows half of the assembly depicted in the drawing. If much maintenance were required, it would be expensive and time-wasting.

Equally severe conditions are met by the special bearing shown on a portable coal mining conveyor roll, which is always wet, in *Fig.* 7. Even need for a shaft shoulder is here eliminated, and again no locknuts or washers are required. The bearing is merely pressed on the shaft as far as it will go. The screened space at the right of the unit is felt or grease packing; next to it toward the ball is a cork seal held tightly in place by a coil spring. Watertight protection is provided axially and sideways.

This article has indicated a few typical applications of bearings with built-in seals, but various other types are available, utilizing seals and shields in different combinations. The designer's needs will permit him to judge if such seals will aid his problem, following discussion with bearing makers.

The following companies kindly co-operated in the preparation of information and illustrations for this article: Bantam Bearings Corp.; Bearings Co. of America; The Fafnir Bearing Co.; The Hoover Ball & Bearing Co.; Marlin-Rockwell Corp. (*Figs.* 2 and 7); New Departure division, General Motors Sales Corp. (*Figs.* 1, 5 and 6); Nice Ball Bearing Co.; Norma-Hoffmann Bearings Corp. (*Figs.* 3 and 4); Shafer Bearing Corp.; SKF Industries Inc.; The Torrington Co.

Although some properties of metals can be calculated accurately on paper, the problem of tensile strength is unsolved, Dr. Saul Dushman, General Electric Research laboratory, said recently. Ultimate tensile strengths of metals, he said, are only one-tenth to one-hundredth of what theoretical calculations say they should be.

Confusion is reduced by graphically showing primary flight information on one instrument. Experimental installation is in a twin engine Boeing transport plane

Single Instrument Indicates Flight Conditions*

By

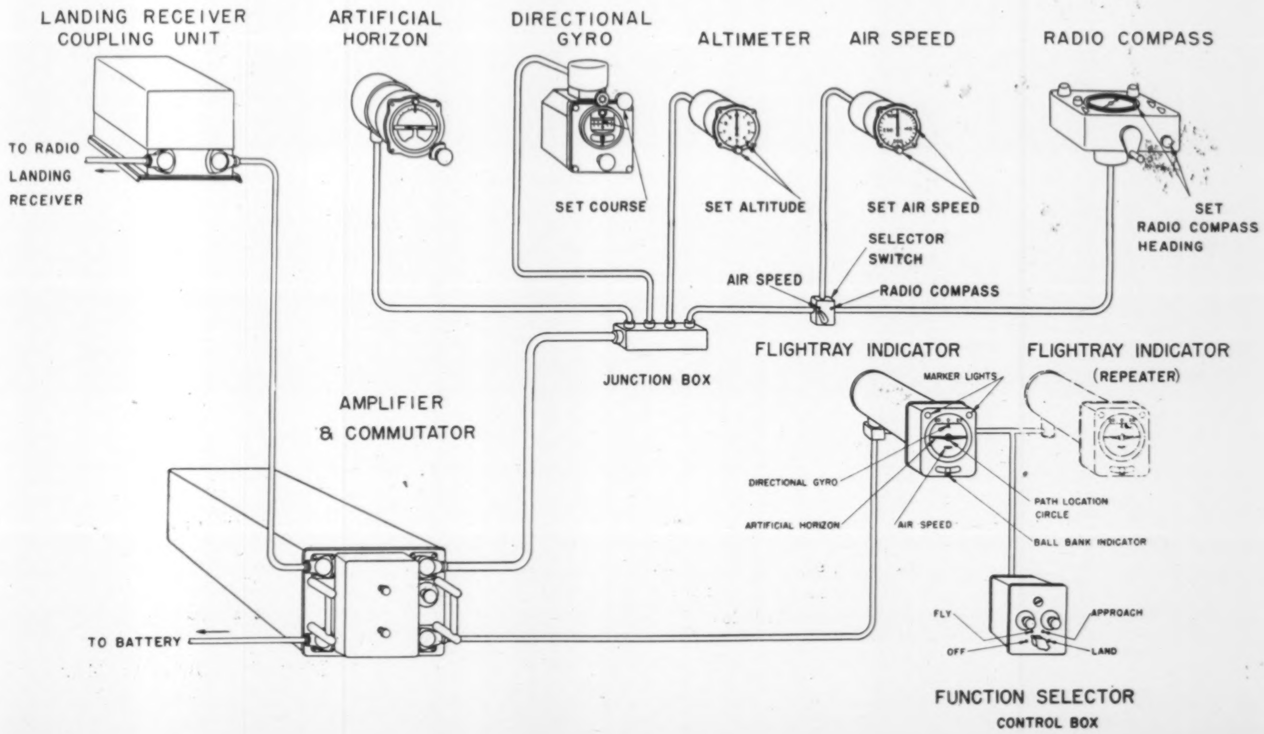
P. R. Bassett and J. Lyman

Sperry Gyroscope Co.

MODERN aircraft, all phases of design of which are now particularly absorbing, has as its nerve-center an extremely complex array of instruments which literally fill the cockpit. Since the efficiency and safety of flight is proportional to the information which the pilot has concerning the functioning of his equipment, the attitude of his ship and his location, this profusion of instruments may be said to be highly desirable. On the other hand, although the instruments are arranged in as orderly a manner as space allows, there are so many instruments necessary that even the most experienced pilots experience confusion.

Some of the pilot's manual controls, of course, have been converted to automatic operation. The automatic pilot, automatic mixture controls, propeller pitch control, carburetor heat control, etc., have all greatly relieved the pilot. But it must be remembered that, although automatics relieve the pilot of manual duties and make it unnecessary for him to watch

One instead of many instruments is all pilot need watch continuously. This schematic diagram shows interconnections of cathode ray indicator with instruments through use of amplifier and commutator unit


LANDING RECEIVER COUPLING UNIT
TO RADIO LANDING RECEIVER
ARTIFICIAL HORIZON
DIRECTIONAL GYRO
SET COURSE
ALTIMETER
SET ALTITUDE
AIR SPEED
SET AIR SPEED
RADIO COMPASS
SET RADIO COMPASS HEADING
SELECTOR SWITCH
AIR SPEED
RADIO COMPASS
JUNCTION BOX
AMPLIFIER & COMMUTATOR
TO BATTERY
FLIGHTRAY INDICATOR
MARKER LIGHTS
DIRECTIONAL GYRO
ARTIFICIAL HORIZON
AIR SPEED
PATH LOCATION CIRCLE
BALL BANK INDICATOR
FLIGHTRAY INDICATOR (REPEATER)
FLY
OFF
APPROACH
LAND
FUNCTION SELECTOR
CONTROL BOX

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*From a paper presented at the annual meeting of the Institute of Aeronautical Sciences.

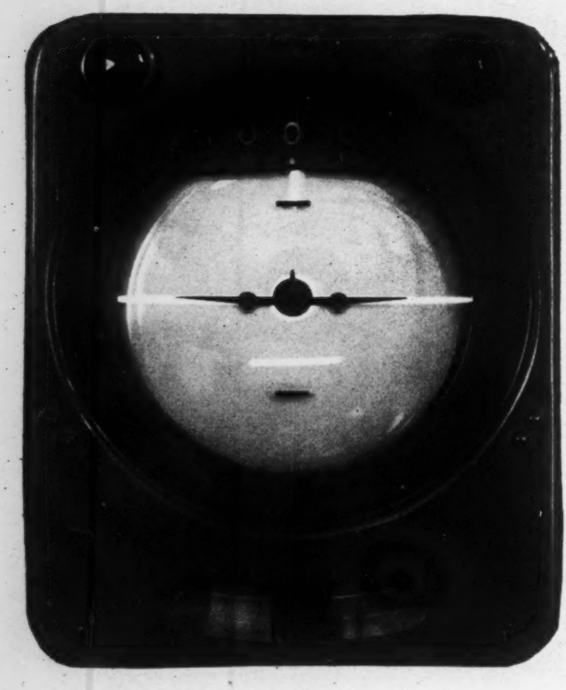
many of the instruments continuously, it does not relieve him of the responsibility for their functioning. Hence monitoring instruments still must remain in view for him to check and the total number of instruments is not reduced.

Present confusion would be eliminated by suitable co-ordination of flight instruments. In a recent approach to this problem, the Sperry Gyroscope Co. developed a single indicating instrument which would show on its face all necessary flight information in an easily interpreted manner. The cathode ray tube was selected as being the best type of instrument for this problem.

Cathode ray tubes have a particular advantage in that a wide variety of indications can be used. By the simple expedient of commutating, it is possible to produce multiple indications of widely different form without interference with each other.

Pictorial Pattern Is Helpful

Selection of a pattern for multiple indication was made on the following premises; first, flight instruments of primary importance must be selected for indication as they are the ones which need the continuous attention of the pilot and must, therefore, be concentrated in the *attention area.* Secondly, the indications of each item must be so different that there can be no confusion such as results from a multiplicity of instrument hands. Thirdly, in the interest of simplicity instead of using scales and numerals information should be as pictorial as possible.



Four conditions of flight are shown on this cathode ray instrument. By use of commutator, signals are each flashed above visible threshold, giving appearance of four simultaneous images. Miniature airplane is "flown"

Pictorial portrayal of information requires first, that a miniature airplane be silhouetted in the center of the screen and second, that the miniature airplane be "flown" in relation to the luminous traces shown on the screen. With the artificial horizon, this technique is well known. The new suggested technique is an extension of the same principle to all indications on this instrument, known as Flightray. To bring the airplane back to a normal altitude, position or heading, the miniature airplane is flown toward any of the luminous lines.

Vertical Line Shows Direction

Directional gyro indications are shown by a short vertical line which moves laterally right or left, to indicate amount of change of azimuth or vertical axis. This makes directional gyro and artificial horizon indications conform in behavior to the horizontal attitude axes indications—both showing amount of change of attitude. The directional indication shows only a limited segment of azimuth—plus or minus 20 degrees. A full scale of 360 degrees was found to be confusing.

There is one method of azimuth indication which has been tested extensively and proved to have particular merit. This is the use of a radio compass for heading indication while making an instrument landing. Further tests of the radio compass are planned, as it is felt its use as a homing device is valuable not only for instrument approaches and landings, but for route flying as well.

Path location is shown by a circle which has complete freedom of movement about the screen. It can be made to indicate from a choice of several instruments. In cruising flight, for example, it is deflected up or down by the barometric altimeter and thus indicates level flight. The sensing of the circle motion has been chosen to be consistent with the ideas of pictorial representation.

When the path location circle is used in making instrument landings, both horizontal and vertical components of motion are utilized. The localizer landing beam is arranged to control horizontal motion of the circle and glide beam controls the vertical motion of the circle.

In making instrument approaches or instrument landings, air speed is important as a protection against approaching stall conditions. It is difficult to show air speed so that it conforms to the pictorial pattern theory. After trying a number of arrangements, however, a short horizontal line which rises across the face of the instrument with increasing air speed was selected. When this air speed line is at the middle of the face, air speed is normal. As the line sinks

(*Continued on Page* 88)

By **Albert B. Willi**
Chief Engineer
Federal Mogul Corp.

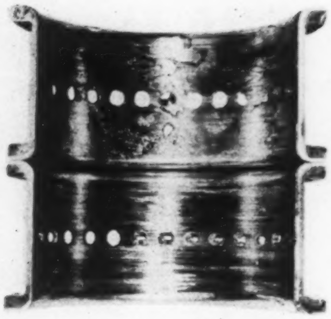


Fig. 1—Cadmium alloy lined bearing run in combination with a soft crankshaft. Alloy has been wiped from upper half and deposited on lower

How Materials Affect Plain Bearing Performance*

HOW to select the proper bearing material for the best results often constitutes a puzzling problem. In the final analysis, the ability of a bearing to resist wear is a criterion of its suitability for a particular application. This article, then, will be confined to wear and related effects on shafts and conventional sleeve bearings. Even thus restricted, the subject is broad and can be covered only by touching certain high spots.

Obviously, in the selection of a bearing material other elements in addition to wear must be considered. But the ability of a bearing to function with a minimum of wear is certainly as important as any.

Excessive wear in bearings and shafts, i. e., the reduction in size which is the result of abrasion, may be caused by improper:

1. Selection of bearing material to suit the shaft
2. Selection of shaft material to suit the bearing
3. Finish of the contact surfaces of both shaft and bearing
4. Lubricating medium
5. Method of distribution of the lubricating medium
6. Excessive operating temperatures.

In selection of bearing materials, choice includes:

1. PHOSPHOR AND LEADED BRONZES—of dozens of compositions; some are sand cast, some chill cast, others cast in permanent molds.
2. TIN-BASE AND LEAD-BASE BABBITTS—may be fabricated as die castings or applied to steel or bronze backs. Here again the range is wide.
3. CADMIUM ALLOYS—are always used in combination with a steel back. In this group, the num-

TABLE I

Field of Usefulness For Various Bearing Metals

Bearing Metal	Maximum Pressure p.s.i	Minimum Permissible Zn/P_{max}	Maximum $P_{max}V$	Oil Reservoir Temp.	Minimum Crankshaft Hardness	Affected by Corrosion
TIN BASE BABBITT Copper .... 3.50% Antimony .... 7.50% Tin .... 89.00% Lead (Max.)........ 0.25%	1500	15	42,500	235° F.	Not Important	No
HIGH LEAD BABBITT Tin................ 5 to 7% Antimony .... 9 to 11% Lead............. 82 to 86% Copper (max.) 0.25%	1800	10	40,000	225° F.	Not Important	No
CADMIUM—SILVER Silver .... 0.75% Copper .... 0.50% Cadmium 98.75%	1800-3850	3.75	90,000 and upwards	260° F.	250 Brinnell	Not likely if temperature is maintained as specified and proper lubricating oil is used
COPPER—LEAD Copper .... 60% Lead 40%	1800	3.75	90,000 and upwards	260° F.	300 Brinnell	

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*From an American Society for Metals paper presented at a recent Peoria meeting.

ber of compositions in common usage is limited to about three.

4. COPPER-LEAD MIXTURES—are used in combination with a steel back. In this group, also, the number of compositions is limited to a few, because of the complicated methods of manufacture.

In addition, there are those which are more or less specialties, and possess a rather limited field of usefulness, such as the oilless bushing, rubber, plastics, bronze with graphited inserts and the like.

In TABLE I, is shown a tabulation defining the field of usefulness of various bearing materials commonly used for internal combustion engine bearings in terms of the usual criteria, including crankshaft hardness. The tin base babbitt listed is a special process bearing material.

Tests Show Wearing Quality

In setting the shaft hardness values, a number of engine dynamometer tests were run equivalent to 8500 miles at 85 miles per hour, using the types of bearings listed in combination with crankshafts of different hardnesses. TABLE II shows the amount of crankshaft and bearing wear involved with shafts of S.A.E. 1045 steel, heat treated to the normal hardness used in automotive practice.

With the cadmium alloy bearings, the shaft wear was not so very much worse than obtained with the tin-base babbitt bearings, but bearing wear was too great. There seems to be an affinity of cadmium for comparatively soft steel, whereby the cadmium wants to adhere or cling to the shaft and the excessive wear is attributed to this characteristic. The condition of this bearing, shown in *Fig.* 1, was caused by running in combination with a soft crankshaft having a brinell hardness of approximately 200.

In the case of the cadmium alloys, when damage results because of lack of shaft hardness and insufficient oil clearance, it is the bearings which are destroyed—the shaft usually comes through in fine shape, if caught within a reasonable time. The same is true of tin-base and lead-base babbitts. With copper-lead or leaded bronze operating under these conditions, the shaft will be worn excessively, scored and ridged; frequently to the point of destruction in a relatively short time.

TABLE II

Shaft and Bearing Wear

Bearing Material	Shaft wear (inch)	Shaft hardness	Bearing wear (inch)	Increase in Clearance (inch)	Coefficient of friction
High Lead Babbitt	.00016 No Scoring	234	.00012	.00040	.115
Tin Base Babbitt	.00025 No Scoring	239	.000086	.00042	.141
Cadmium Alloy	.00029 No Scoring	225	.00021	.00071	.079
Copper-Lead	.00063 Shaft Scored and Ridged	246	.000069	.00077	.150

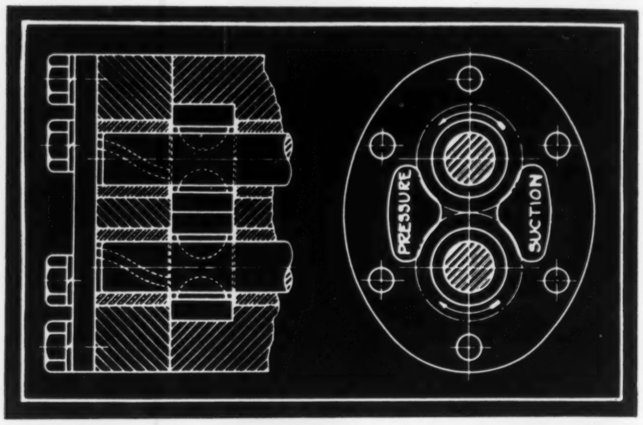
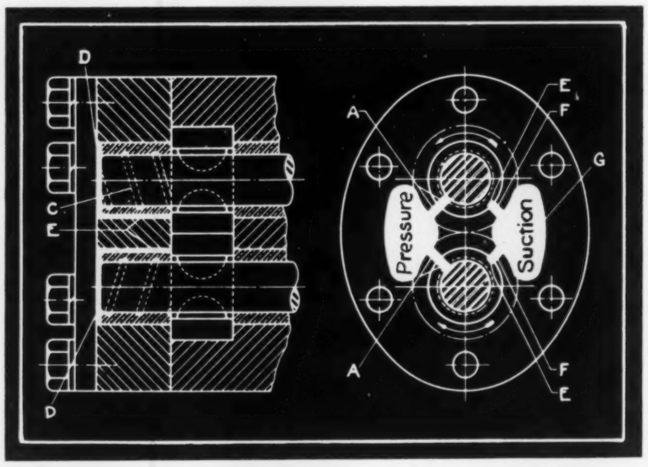


Fig. 2—Pump bearing design unsatisfactory for water lubrication. Shaft tied up almost immediately

Fig. 3—Redesign of pump bearing providing positive circulation of lubricating medium



Brinell hardness of 250 is the minimum safe shaft hardness for use with cadmium alloy bearings and 300 the minimum safe shaft hardness for use with copper-lead bearings. It has happened that in certain cases, even with these hardness values maintained, excessive shaft wear was obtained. It was possible, however, to trace the cause to inadequate lubrication. The remedy is to increase the oil flow through the bearing or provide a still harder shaft.

Bronze Selections More Difficult

To select properly a suitable composition and physical properties for a bronze bearing or bushing is more difficult because the mechanisms in which they are used are widely diversified. In TABLE III is shown an imposing list of points which must be considered whenever any bronze bearing material is to be selected.

Fourteen bearing bronze compositions are listed in TABLE IV in the order of their qualities as bearings. These bearing qualities and physicals are normal to sand castings.

When it is desired to select a bearing bronze, then,

TABLE III

Points Involved in Selecting Bearing Materials

Work Factors

- Unit pressure, lbs./sq. in.?
- Constant load?
- Shock load?
- Intermittent load?
- Load reversal?
- Rotating shaft?
- Oscillating shaft?
- Sliding shaft?
- Rotating bushing?
- Shaft speed. ft./sec.?
- Operating temperature?

Lubrication

- Grease specification?
- Oil specification?
- Non-lubricating liquids—(Gasoline, water, etc.)?
- Pressure lubrication?
- Splash lubrication?
- Oil or grease cups?
- Mechanical oilers?
- Ring or wick oiling?
- Running clearance?
- Is there any lubrication?

Special Design Features

- Space available for properly proportioned wall thickness?
- Grooving system for lubricant distribution?
- Protection against entrance of foreign matter?
- Finish of bushing?
- Thrust requirements?
- Acids, corrosive liquids or fumes present?
- Material of housing and its structural stiffness?
- Shaft material, hardness, finish, deflection?

it is necessary to correlate the points of design and operation in TABLE III and also the bronze chemical compositions and physical properties of TABLE IV. These bronze specifications would be increased if the results and effects of other methods of fabrication, such as chill casting, permanent mold casting, extrusion, cold working, etc. are considered.

To obtain a selection without too much confusion, it is of course, customary to work from an "aiming point" using an existing and familiar bearing installation in as nearly similar mechanism as possible. By balancing off the differences in design and operating conditions against the characteristics and properties of the bronzes, a good selection can be made.

As an example, a case history of a bearing installation is interesting. A certain ½-horsepower plain bearing pump was successful for pumping various oils, but it could not be used for water or other non-lubricating liquids because the shaft tied up in the bearings almost immediately. The construction adjacent to the bearings is shown diagrammatically in *Fig.* 2. Shafts were Nitralloy steel and the bearings rolled bronze strip (88 per cent copper, 4 per cent tin, 4 per cent lead and 4 per cent antimony). Shaft speed was 3450 revolutions per minute, 451 feet per minute surface speed.

Two obvious features indicating the impossibility of using water as the so-called lubricating medium are the water cannot circulate freely within the bearing and the bearing metal composition is too low in bearing qualities for high operating speeds, unless good lubrication is provided.

Redesign Provides Positive Circulation

To provide positive circulation of liquid through the bearings, the pump was redesigned as shown in *Fig.* 3. A metered quantity of liquid is taken from the pressure side of the pump, through milled channels *A* into spiral grooves *C* in the bushings, which are of the proper direction to tend lightly to pump the liquid back into chamber *D* at the end of the shaft. A groove *D* is milled lengthwise on the outside diameter of the bushing, through which the liquid flows, or is drawn, from chamber *D* back through channels *F* to the cavity *G* on the suction side of the pump.

With a bushing of sand cast bronze, stainless steel

TABLE IV

Bearing Bronze Compositions and Qualities

	COMPOSITION				BRINELL HARDNESS								—Blows—		Load To Compress	
Material	Cu. %	Sn. %	Pb. %	Zn. %	75° F.	150° F.	250° F.	350° F.	Tensile Strength (p.s.i.)	Elong. (% in 2")	Red. in Area (%)	Coeff. of Dry Frict.	to Deform 1%	to Deform 5%	.001 in. (p.s.i.)	.01 in. (p.s.i.)
Leaded Bronze*	Balance	2-4	30-37	1 Max.	35.5	....	....	....	19,500	10.5	7.5	....	..	...	......	.....
Plastic Bronze	Balance	3-5	23-27	....	42.1	41.3	39.9	38.0	21,100	15.7	15.7	.165	3	23	10,000	14,000
Leaded Bronze	72-74	6-8	18-20	....	47.0	....	....	....	25,000	16	14	....	..	...	......	......
Leaded Bronze (S.A.E. Spec. 67)	76.5-79.5	5-7	14.5-17.5	4 Max.	50.0	....	....	....	27,000	17	11	....	..	...	......	......
Bronze	Balance	11.5-13.5	13.5-16.5	....	69.0	....	....	....	30,000	5	....	.149	..	...	......	......
Bronze (S.A.E. Spec. 66)	83-86	4-6	8-10	2 Max.	52.2	52.5	49.8	48.6	31,000	16.5	20.2	....	5	65	. .	.....
Leaded Bronze	69-72	8-10	19-21	....	59.6	58.5	57.2	52.6	31,300	15.9	14.6	.14	15	760	14.400	20,000
Bronze	81-85	6-8	6-8	2-4	53.3	52.3	51.5	49.9	33,900	23.2	23.8	...	6	225	14,000	19.500
Bronze (Red Brass)	83-86	4-6	4-6	4-6	56.1	....	....	....	30,400	20.2	22.4	.16	..	...	14.500	17,500
Phosphor Bronze (S.A.E. Spec. 64)	78-81	9-11	9-11	....	63.6	61.1	58.8	55.7	39,800	29.4	27.2	.15	16	1000	14,000	27.700
Bronze (Ford "Z" Metal)	85-89	7.5-8.5	.75-1.5	2.25-4.75	58.0	....	....	....	45,000	42	31	....	..	....	......	......
Bronze (S.A.E. Spec. 62)	86-89	9-11	.....	1-3	65.8	64.0	60.0	57.9	48,400	47.9	41	.145	22	1000	16,000	22,000
Bronze (S.A.E. Spec. 63)	Balance	9-11	1-3	1.5 Max.	69.0	....	....	....	46.000	40.5	31.5	.15	..	....	......	......
Bronze (S.A.E. Spec. 65)	88-90	10-12	.....	....	70.0	....	....	....	52,000	47	....	...	..	....	......	......

*A maximum of 1 per cent nickel is included.

shafts having a brinell hardness of 185 and water as the lubricating medium, good results were obtained. Shaft wear amounted to less than .0003-inch in fifty hours.

Effect of Cracks on Life

I want to return for a moment, to certain characteristics of bearings lined with the so-called white metals—such as tin-base and lead-base babbitts. Small cracks and cavities in a babbitt lining are frequently considered as prima facie evidence that the bearing is a total loss, and that complete failure is to be expected at any moment.

In a steel connecting rod, or crankshaft, a crack is definitely an indication that complete failure may occur at any moment. However, a steel, or bronze back bearing lined with tin-base babbitt, high lead babbitt, or cadmium alloy, is of an entirely different nature, and the development of cracks or cavities from their incipient stages to the point of deterioration, where engine performance is affected or complete failure occurs, seems to be a relatively slow process—if the lining is properly bonded to the back.

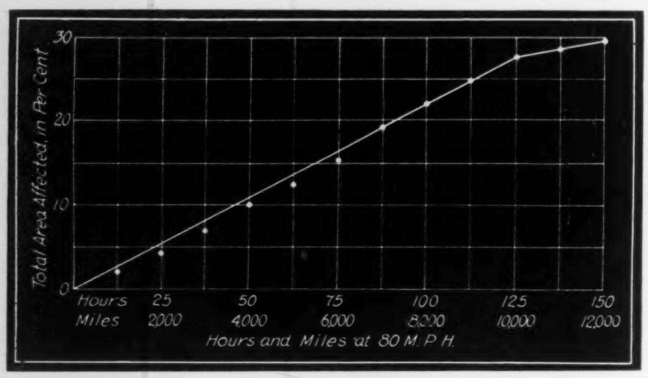


Fig. 4—Progressive development of cracked areas and cavities in tin base babbitt bearings

As an example, a set of steel back tin-base babbitt lined connecting rod bearings were examined after a dynamometer test of 12½ hours at an engine speed equivalent to 80 miles per hour, or a total of 1000 miles. Certain hairline cracks were observed to affect 1.96 per cent of the total developed bearing area.

Twelve and one-half hours seems like a short period for deterioration to set in, but this characteristic has been observed in many other cases when the lubrication was rated inadequate. The test was continued, and at each 12½ hour interval, the bearings were removed and checked for areas of cracks and also loss in weight.

Areas covered by cracks and cavities after 150 hours amounted to 29.86 per cent. Up to this 150 hours, the engine has functioned normally, with no drop in oil pressure, no change in oil temperature, no bearing bumps, raps, or other manifestations of distress, and no change in oil consumption, so it is concluded that in spite of the cracks in the babbitt, the practical effective life of these bearings is at least the 150 hours which they have been run.

Rate of development of cracked areas in these bearings is shown in *Fig.* 4 and amounts to approximately 2.53 per cent for each 12½ hour (1000 mile) interval up to 125 hours, where it drops off slightly.

If bearings with a certain order of cracks and distress after 1000 miles can continue to render satisfactory service for 11,000 additional miles of the hardest kind of breakdown test, without affecting engine performance, undue concern over early development of minor cracks is hardly warranted.

Operation Without Lubrication

One of the most frequent demands is for bearings which will function without lubrication. An elementary test rig was set up to determine which of the conventional bearing materials would function the longest without lubrication.

A ½-horsepower electric motor was used, with a speed of approximately 800 revolutions per minute. The end frames were reworked, so that the bearings fitted with .002-inch clearance could readily be replaced. No load was applied, other than was normally developed by running the motor idle. A brief summary of the results is shown in *Fig.* 5.

The time shown indicates the number of minutes of running before the shaft seized, although there was plenty of squealing and signs of distress before the actual seizure occurred.

It is interesting to note that the bearings completely lined with lead base babbitt or inlaid with either lead base babbitt or pure lead were considerably inferior to those completely lined with a tin base babbitt, or inlaid with tin base babbitt or pure tin. It is also interesting to note in this connection, that the coefficient of dry friction of the lead base babbitt is higher than the tin base babbitt. The bronze bushings which were inlaid with either lead or tin showed to best advantage. The bearing surface consists of alternating diagonal lands of bronze and whatever metal is used as the inlay.

Aluminum Alloy Is Promising

Recent experimental work has established certain promising features for aluminum alloy bearings if they are applied under proper conditions of design and operation. In England, aluminum bearings are used in Diesel engines for regular production.

Brinell hardness of a successful English aluminum-tin alloy is about 65. This is considerably harder than copper-lead bearings, which usually run somewhere around 40 to 45 brinell, so the question of shaft hardness becomes important. So far, it appears that aluminum bearings must be used in connection with a hardened shaft.

In *Fig.* 6 is shown a set of aluminum alloy connecting rod bearings, after a full load endurance test period of 450 hours in an automotive type diesel engine in connection with a hardened crankshaft. The 450 hours is the equivalent of 22,500 miles.

In this set of bearings, there are two types of alloys; those marked "hard" had a brinell hardness of 105, those marked "soft" were 60 brinell. Incidentally, neither type possesses the improved qualities of the latest developments which are available in this type of material.

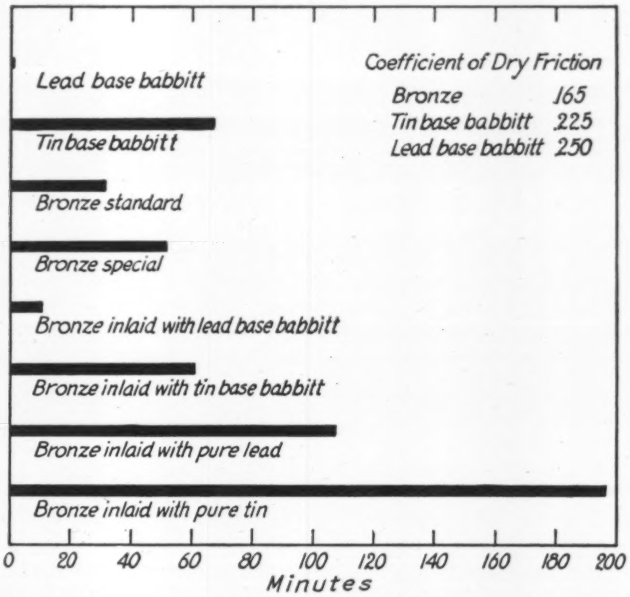


Fig. 5—Comparative ability of selected bearing materials to function without lubrication

In spite of this, an interesting feature showed up in the matter of increase in oil clearance—which is a function of shaft and bearing wear. Wear expectancy or increase in oil clearance of slightly over .003-inch is normally expected on tin-base babbitt bearings operating over this period. With the "soft" aluminum bearings, however, the oil clearance increase amounted to .0023-inch and with the hard aluminum, the increase amounted to .0027.

To sum up, the wear obtained with aluminum alloy bearings having properties admittedly inferior to what is now available appeared to be less than what not so long ago was considered normal for tin base babbitt bearings.

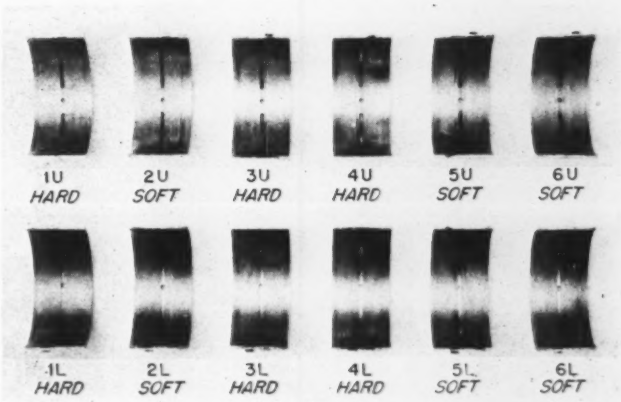


Fig. 6—Aluminum alloy bearings after 450 hour endurance test. Rubbing speed 22.2 feet per second

An interesting example showing minor changes for the sake of economy may cause bearing failures is illustrated in a shackle bushing design. The bushing was considered mechanically corect. Two "Figure 8" grooves, spaced 180 degrees apart, are provided on the inside diameter which are connected with an external annular groove by 5/16-inch diameter transfer holes. The lubricating grease is introduced into an external groove through a pressure gun fitting. The grooves are broad and shallow, as is necessary when grease is used as a lubricant. For about six years this job never caused any difficulty. Then trouble started. Bushings were returned peaned and extruded over the ends in the shock load area, hardened shackle bolts were worn down and cut to pieces, all within a few months service.

Changes Caused Failure

It developed that changes had been made unknown to the engineering staff, because as a matter of routine, it is a physical impossibility to check every print and every change for design angles.

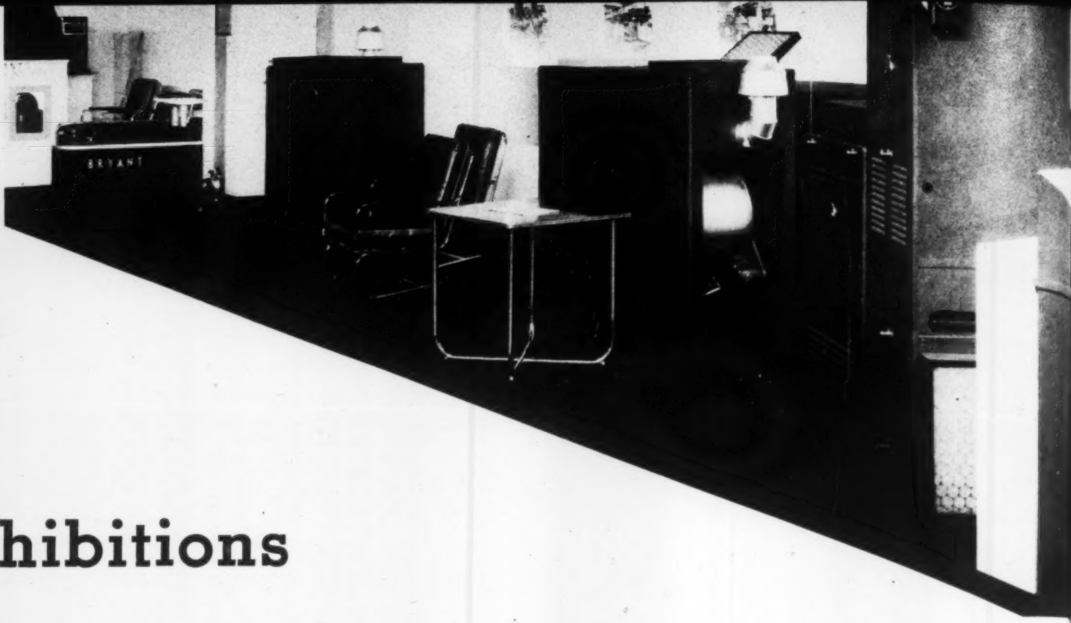
In the first place, to reduce cost, one internal figure 8 groove and its transfer hole had been eliminated, which reduced lubricant distribution 50 per cent. The bronze composition had been changed to provide a stronger alloy, but with inferior bearing qualities.

Also—the grease specification used at the factory and recommended for use in the field had been changed. Corrections were easily effected by simply canceling all these changes.

Excessive heat is certainly a bitter enemy of long-lived bearings and shafts. Over the years, many schemes have been evolved for conducting heat from the bearings more rapidly. To determine the effect of heat reduction through the bearings themselves, tests were run on bearings with highly conductive alloy backs.

Practically the same areas of distress and failure were obtained in these tests as was experienced with conventional designs. This conclusion is probably reasonable because both types of bearings were assembled in a steel connecting rod and the oil temperatures were the same in each case.

It might be mentioned in conclusion that bearing problems are not as puzzling as usually considered, providing each factor is taken in turn and an analysis made of design, selection of bearing material and type of service.



Air conditioning units and furnaces at the Heating and Ventilating exposition showed a distinct trend toward easily maintained "streamline" construction of lighter metals

Recent Exhibitions Indicate Machine Trends

CONVENTIONS and expositions hold unusual interest for designers because the machinery exhibited represents the latest developments in the fields involved besides furnishing ideas for use in other types of machines.

Last month witnessed the Sixth International Heating and Ventilating exposition in Cleveland; the Canners' convention and the Road show in Chicago. The machinery shown naturally was somewhat specialized in nature but trends in design were apparent which may be said to apply to virtually all modern equipment. Brief summaries of these trends are presented in the following.

Furnaces, air conditioning units and stokers at the Heating and Ventilating exposition almost without exception were of box-like construction. Back of this trend, of course, is the aim for cleaner exteriors and better appearance of the surroundings in which the machines operate.

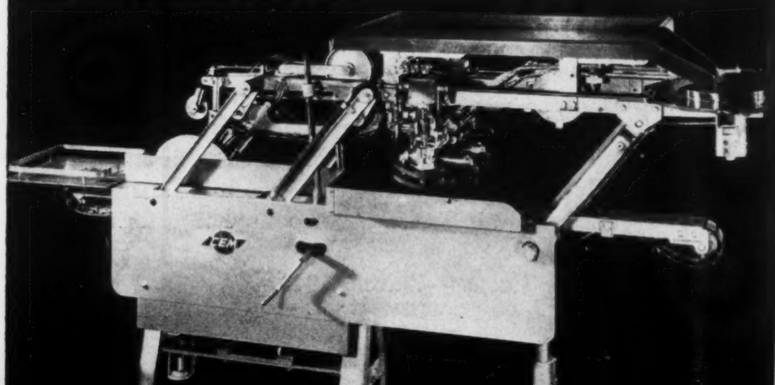
In general, lighter metal is being used, particularly galvanized iron and steel sheets and aluminum. As usual, copper and brass were in high favor for fittings. Cast iron remains indispensable for stokers.

Controls have been simplified and reduced in number. Typical was the largest piece of equipment, a combination heating, cooling, or simultaneous heating-cooling machine adapted for apartment house installation, which is controlled by a tiny klixon, the size of a dime.

Both smooth and rough or wrinkle finishes were used on equipment, as well as those with smooth surfaced, two-tone hammered metal effects. The latter type represented an attempt by some manufacturers to return to smooth surfaces with a somewhat different appearance than formerly. Quick-baking continues to be a feature of some of the newer finishes. Two new types of insulation were shown, one for which new applications are being found containing 85 per cent magnesium and 15 per cent asbestos. Another insulating material was faced with aluminum foil.

So far as possible, heating and ventilating equipment is being made automatic. Examples on display

Easily adjustable for various size containers, tractor type capper mechanism is supported on three sets of arms, in form of pantograph. Seen at Canner's Convention



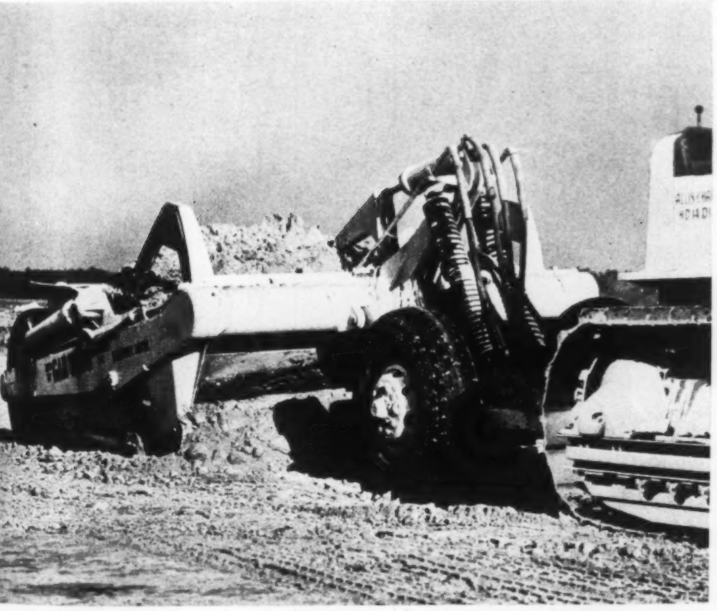
included automatic electrically-operated boiler return traps, for high pressure boilers and a completely automatic air conditioner burning bituminous coal.

Fans for refrigeration units and those for general air circulation were quieter in operation and more efficient. Increased rigidity and reduction in weight were achieved in one interesting blower by fabricating the blades in one complete strip. In machines like oil burners, silent operation is attained through close coupling and accurate alignment of motors and pumps.

Canning Machinery Speeds Up

MACHINES displayed at the Canners' Convention exhibit marked improvements in many features of design. Increased uses of stainless, welding and "clean-lined" designs make the machines easier to clean and maintain. Light weight alloys are being applied to high speed reciprocating parts to reduce inertia, vibration and resultant noises. Cam motions, characterizing this type of machinery, provide smoother and more trouble-free operation than formerly.

Higher operating speeds and increased automaticity have been responsible for the redesign of a considerable number of auxiliary mechanisms. In some cases solenoids are required to operate throwouts where formerly gravity was sufficient. Interlocks to provide shutdown in case of inability of any part to function have been improved and extended to take care of the higher speeds. On a labelling machine, provisions have been incorporated to replace label stock without a shutdown through the use of an auxiliary feeder.



Alloy steel scraper is welded, using tapered side frames to increase load carrying capacity. Control of operations is hydraulic. Springs aid in lifting blade

Interesting also is the increased use of rubber parts. A corn husking machine utilizes rubber rolls with a helical ridge to remove husks. Strangely, these rolls outlast any material formerly tried. Rubber starwheels are employed on several machines to feed glass bottles or jars to their stations. Increased speeds, quieter operation and less damage from breakage result.

An indication of the versatility required of canning machines to be adjustable and to function under varying requirements is illustrated by the capping machine developed by the Crown Cork and Seal Co. A pressure fitted cap is automatically fed to each filled glass container and is applied by a tractor type of capper. The entire capping mechanism is supported on three sets of arms and can be raised or lowered, for varying jar heights, by a single crank. Adjustment for various widths of caps is made by a key which widens or narrows the cap chute, a dial showing the width set.

For cap adjustment tension at the exit point of the chute three thumb screws are provided. Two sets of driven V-belts, synchronized with the speed of the conveyor, can be raised or lowered for properly gripping the filled jars as they pick off the caps from the exit end of the cap chute—thus preventing any upset of the jars. Overriding the capping tractor is a fabric belt which is also synchronized with the tractor and conveyor chain. This overriding belt levels the cap so that it is perfectly aligned prior to being pressed home by the tractor capper.

Lighter Road Machines Developed

ROAD building and maintenance machinery although conventional insofar as operation and appearance are concerned, shows marked improvement in increased capacity for work and ease in handling. Weight savings through redesign and use of welding and lighter-weight alloys have increased the load-carrying capacity of earth movers as well as reduced the base weight required for shovels and digging equipment.

Even with increased capacities and larger units, the maneuverability and ease of control of contractors' equipment are improved over previous designs. Hydraulic operation and control are applied to almost every type of equipment and represent an increase of about 20 per cent in application during the past year. For example, hydraulics are applied to steering mechanisms, control of scrapers, finishers, shovels, pavers, snow plows, etc. On a paver built by the Ransome Concrete Machinery Co., the application of hydraulic control to boom swing, water feed and two chutes facilitated design and reduced the number of parts needed by more than 100.

With development of higher capacity machines the power source is an important feature. For this type of equipment, the diesel is well suited and has been applied to the majority of heavy units.

Illustrated is a Gar Wood hydraulic scraper, powered and controlled by an Allis-Chalmers tractor. Independent hydraulic operation controls lift, bowl and gate with power up or down. Two large springs at the front store energy when the blade is lowered into the ground, this energy being returned in lifting the blades when maximum power at the draw-bar is most needed.

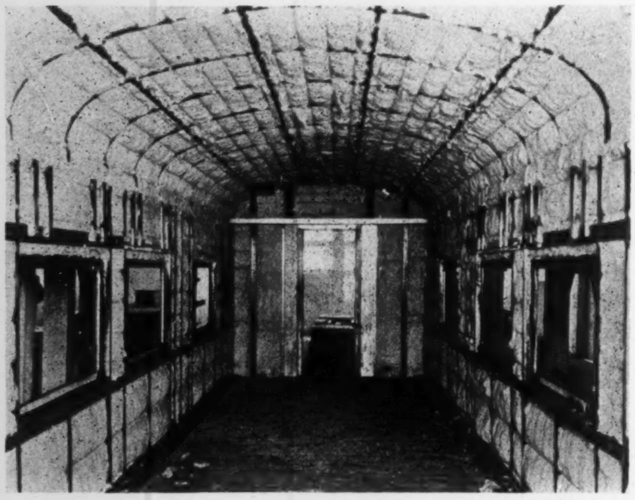
This scraper is alloy steel throughout, welded from plate. Side frames are tapered, the deep section being at the bowl pivot where the load is concentrated, thus forming a beam of adequate strength with less material and weight than required of a rolled beam of uniform cross section.

Another interesting earth mover is the newly designed motorized Galion Cyclone which digs, carries and spreads. With the aid of a pusher tractor, greatly increased power is available when needed at the cutting edge. Ease of operation and auxiliary power for digging make it an efficient and economical design.

Insulating for Passenger Comfort

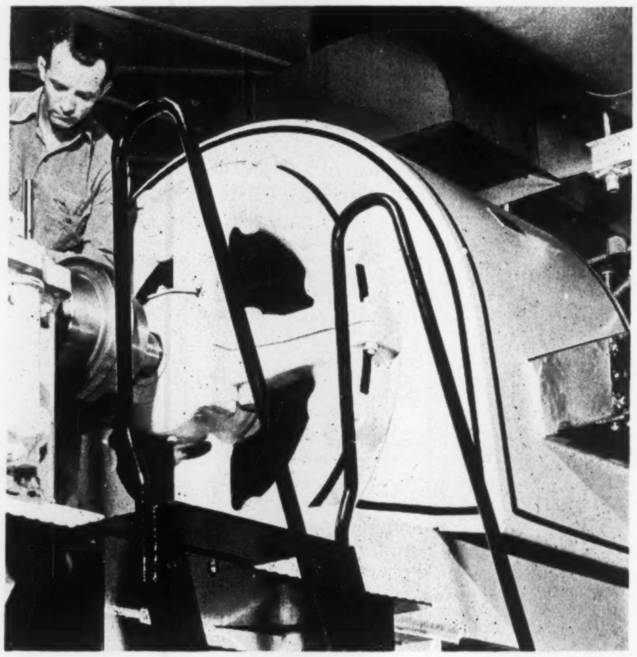
COMPLETELY insulated to provide both heat insulation and sound absorption, this view of a car for the new Missouri Pacific Eagle shows the insulating material in place in the shell-type frame. In addition, the trucks, couplings and floors have special provisions for sound deadening. Floor is pressed aluminum alloy in the shape of a keystone cross section. Cork and floor coverings add to the insulation properties. A complete air conditioning system employs steam jet cooling and vapor heating.

Consisting of underframe, sides and roof, the shell constitutes the load carrying portion of the car body. The center sill is a combination of angles and plate capable of resisting all buffing and pulling loads. Extending from the center sill backbone are low alloy, high tensile steel bolsters and five steel intermediate cross-bearers, forming the support of the sides. Intermediate floor of aluminum alloy supports also extend from the center sill and carry the main floor. Sides are aluminum girders, the bottom flange being a special extruded section so designed as to carry its load and yet form an airtight barrier. Roof is sheet, riveted to extruded sections and ends are extruded alloy to meet antitelescoping and shearing requirements.



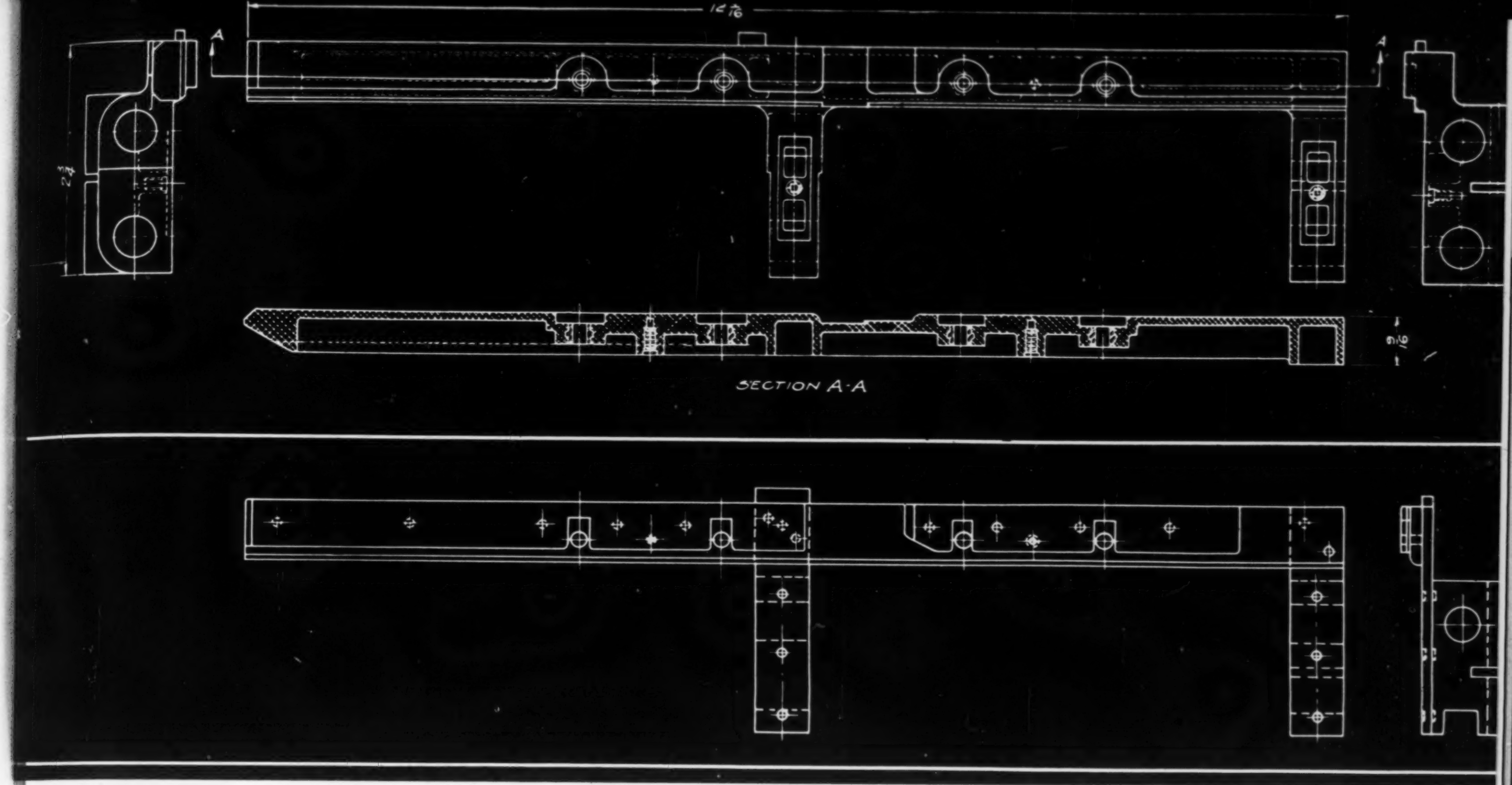
Massive Motor Has Low Noise Level

VIBRATION and noise have been reduced to a minimum in this 1000-horsepower synchronous motor through special design and correctly proportioned electrical and mechanical parts. To illustrate the degree of refinement, the coupling—a small part of the rotating element—is a press fit on the motor shaft. The entire unit, even though massive and powerful, has a low sound level of 83 1/3 decibels.



Operating at unity power factor, this 1200 r.p.m., 3-phase, 60-cycle, 208-volt Westinghouse motor drives an air conditioning installation in the International Building, Rockefeller Center. At full load, the synchronous unit is 1½ per cent more efficient and costs 10 per cent less than a wound type motor.

Locked rotor or starting current is 9500 amperes. Since the maximum load that may be applied without affecting the system is 3200 amperes, it is necessary to hold the starting value within this limit. The control, essentially a bank of resistors with relays and contactors, keeps the current additions within this value and is timed to permit regulators to restore normal voltage. Full load current is 2160 amperes.



Die Casting Fundamentals Point Way to Extra Savings

CERTAIN specific details relating to the design of die cast parts are often overlooked, although if borne in mind they result in substantial savings of cost through reduced machining and assembly. Unless the designer has close contact with production operations he may never appreciate how seemingly minor items mount up. Several instances showing how savings may be made have been brought to light in recent months and are here discussed.

One example of a major saving, such as often can be realized by using a single die casting in place of an assembly of several parts made by other means, may be cited first. *Fig.* 1 shows a one-piece die casting and below it the equivalent part as originally designed for production from cold drawn and cold rolled steel, the assembly being made by projection welding after certain broaching, drilling and other machining was done. Total tooling cost for the assembly was estimated at $1985, and the estimated cost of the completed part in lots of 500 was 97.7c each. For the die casting the total tooling cost, including the die, tools for removing flash, a special reaming jig and reamers, amounted to $1654. Price of the piece, straightened and reamed, is now 51.9c in lots of 500.

Besides reducing the tooling cost more than 16 per cent and piece cost nearly 50 per cent, the die casting yields a part of more favorable shape. It also includes cast-in bushings and recesses for flat headed pins, bosses for screws and cored recesses serving as oil wells. The latter are adjacent to porous bronze bushings inserted after casting, to provide bearings for rods on which the piece is reciprocated parallel to its length in the finished machine. These features were not possible in the earlier built-up piece. The latter became a unit by welding the joints, but many other assemblies of wrought parts are built up by using pieces which may loosen in service.

Fig. 1 also shows some benefits realized by simple

Fig. 1—Above—Part die cast from zinc alloy in one piece is at top, and beneath it the corresponding assembly produced by joining several steel parts together

coring in a die casting. Most cores placed at right angles to die partings are inexpensive, adding little to die cost and often saving much machine work as well as saving metal. It is quite usual to core holes for bushings and often they are cast in place, as in the illustration.

If the inexpensive flanged type of porous bronze bushing be used, it is feasible to core not only the hole for the bushing itself but that for the oil hole as well, as shown in *Fig.* 2, section C-C. Usually such holes are drilled at an angle, requiring an extra operation for each hole. The oil hole in *Fig.* 2 is formed merely by providing a small projection on one side of the core forming the bushing hole, leaving a recess in the boss. When the bushing is pressed in subsequently, one side of the recess is closed but a hole through the side of the boss remains and it can be made large enough to hold a piece of wicking and considerable oil if desired, the oil feeding gradually through the pores in the bushing. If necessary, a dab of shellac or of litharge can be put on the inside of the bushing flange before the bushing is pressed in place to seal the space around the oil hole.

Holes which are to be tapped subsequently are often cored in die castings to save drilling. If the tap passes through a flat surface such as a boss or the foot of a bracket, it may leave a burr which is likely to prevent the piece from seating properly. If, however, the core is made to form a counterbore or shallow recess where the hole passes through the face which should be perfectly flat, the burr will come in the recess or counterbore and not interfere with a good fit. *Fig.* 3 is such a case. There is, of course, no significant difference in the cost of a core pin with a stepped diameter to form the counterbore, and that of a straight core pin, but the saving in assembly time with the counterbore or recess may be considerable.

Slots Trued by Milling

Slots are sometimes cored in die castings and, if they are to receive a wear resistant guide block (as in *Fig.* 2, section D-D) or some similar part, it may be necessary (if greater accuracy is required than the cored slot affords) to true the slot with a light milling cut. This will insure proper seating of the block on surfaces without draft. For a short guide block a pair of bosses formed by countersinking the core will provide an adequate seat in the bottom of the slot, and two pairs of bosses at the sides of the slot will prevent any side motion of the block. If the bottom bosses have a diameter somewhat smaller than the width of the slot and cores are provided from the back to form voids as at points marked *"x"* in *Fig.* 2, no metal need be cut away at the lower corners of the slot when the bosses are trued by milling. In consequence, if the milling cutter's square edge becomes dull (which it is prone to do when it has to form a square corner in a slot) no metal remains in the corners to prevent accurate seating of the guide block at assembly. This may seem a very minor consideration, but if it is overlooked and extreme care is not exercised by the shop in milling the groove with sharp corners, much difficulty and costly delays are likely to occur at assembly.

A common way to make a light lever which requires a hub to fit over a shaft is to blank the lever from sheet stock, turn a hub on a screw machine and fasten the two parts together by riveting, brazing, welding or some similar method. Often the part is subsequently fastened to the shaft by a taper pin or setscrew. Although this practice is sometimes satisfactory, it involves fastenings which may work loose in service, especially under shock or stresses alternating in direction. Two parts must be made, handled and assembled.

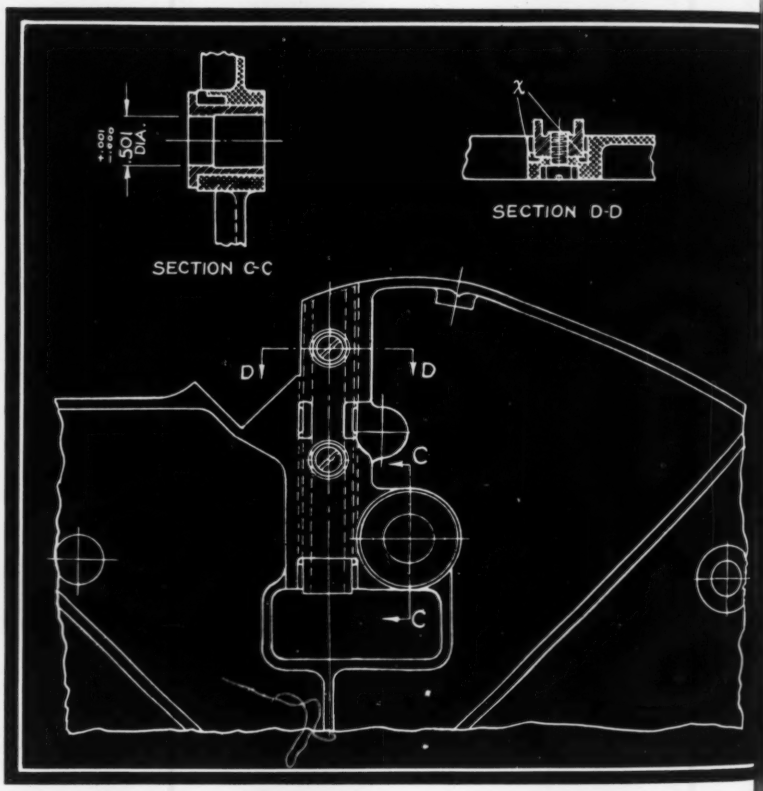


Fig. 2—Portion of a die casting showing, at section on C-C, how an oil hole is cored to obviate separate drilling. When a slot is cored in a die casting, as shown at section D-D, clearance produced by coring around bosses, leaving spaces marked "X," helps to avoid difficulties in machining and assemby, such as guide block seating

Often a better and less expensive procedure is to die cast the hub and lever in one piece (adding other parts, when they are needed, with only minor added cost in the one-piece casting), making the die so that the hub is split. Some extra metal may be left to provide room for drilling and tapping for one or more clamping screws, as in *Figs.* 4 and 5.

In a die casting, the hole can have, without significant extra cost, a flat or spline for positive positioning on the shaft, but in general this is not required.

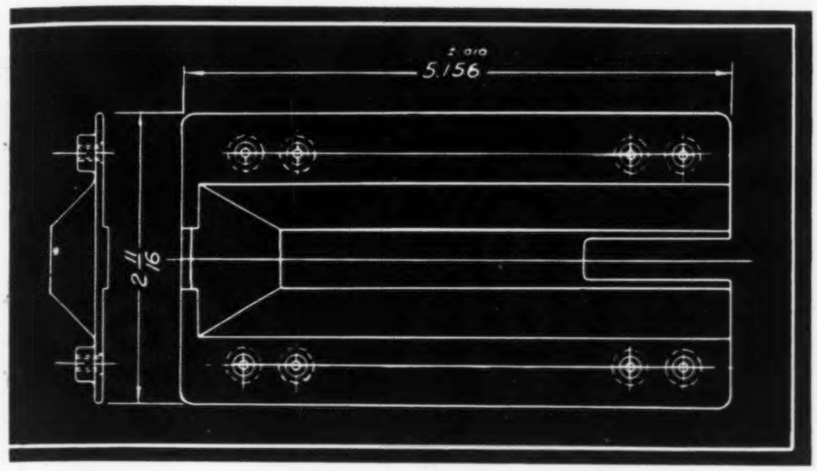


Fig. 3—Recesses cored around the ends of tapped holes in this die casting prevent any burr thrown out in tapping from interfering with firm seating of the flat face of the casting against a mating part

If the hole is made to fit the shaft well the clamping screw provides a secure fastening and no taper pin is required. Assembly is simplified, as there are no holes to drill and adjustments in position, as for taking end thrust, are readily made, both in assembly and in subsequent service. Of course, the die casting can have a boss added at the end of the lever, as in *Fig.* 4, without adding appreciably to cost, or an insert, such as the pin in *Fig.* 4, can be cast in place or can be pressed into a cored hole subsequently.

Properly designed inserts which are cast in place are not only held securely, but often afford qualities—such as hardness and superior bearing properties—not available in a die casting without the insert. Examples of this are seen in *Figs.* 1 and 4. Unless the insert makes an unusually tight fit in the die, however, flash is formed on projecting surfaces.

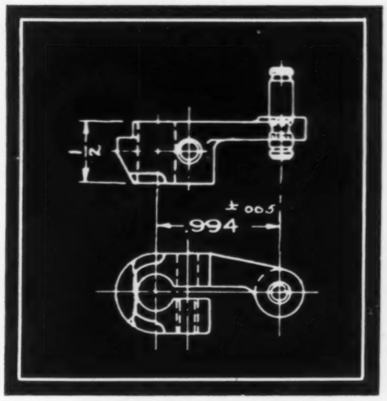


Fig. 4—Left—Lever die cast with split hub and with insert cast in the boss at the outer end

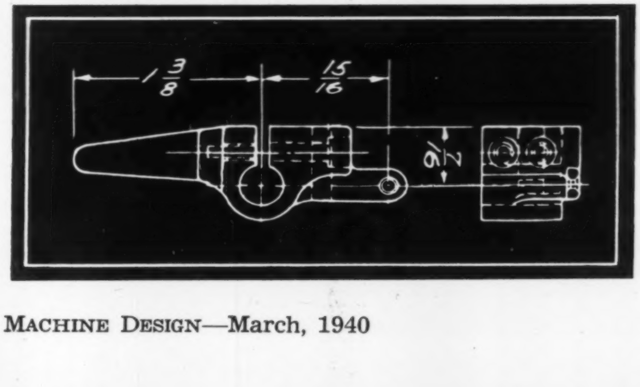


Fig. 5 — Below — Compound die cast lever with split hub designed to provide sufficient room for two clamping screws

If a pin insert, as in *Fig.* 4, does not have a stepped diameter adjacent to the point where it fits into the casting, the flash may interfere with a part fitting over the pin and seating against the boss of the casting, thus necessitating removal of the flash. This can usually be avoided by providing a step on the pin so placed that the pin fits tightly against the step when the die closes. The stepped face, being silghtly above the boss face, prevents the flash from turning a corner and depositing on the cylindrical bearing face of the pin.

Bushings, like those for the pins in *Fig.* 1, are often cast in place and if they are a tight fit on the pins used to position them in the die, may not even require reaming to make them ready for service, although a light reaming cut is often required. It is even possible to make a cast-in bushing adjustable endwise, if a fairly coarse thread be used on its external diameter and a projecting hex, a slot, or other means of turning it be provided. In this case, however, the thread should be well coated with graphite before the bushing is inserted in the casting die, as otherwise the metal of the die casting is likely to freeze to it so tightly that turning is impossible.

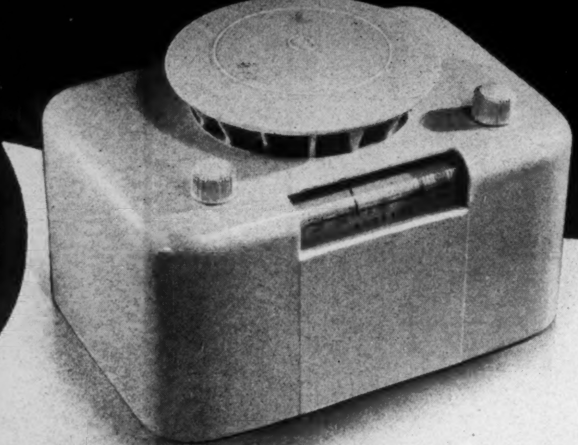
Bushings May Be Applied

Similarly, if the bushing is bored with the hole eccentric to the outside diameter and the latter is made smooth and is coated with graphite before metal is cast around it, the bushing can be turned to adjust center distances. It is, of course, entirely feasible to apply bushings, either adjustable or fixed, subsequent to casting. This may increase machining cost somewhat on the casting, but the latter may be offset in whole or in part by shortening the casting cycle through saving the time otherwise required to place the inserts in the hot die.

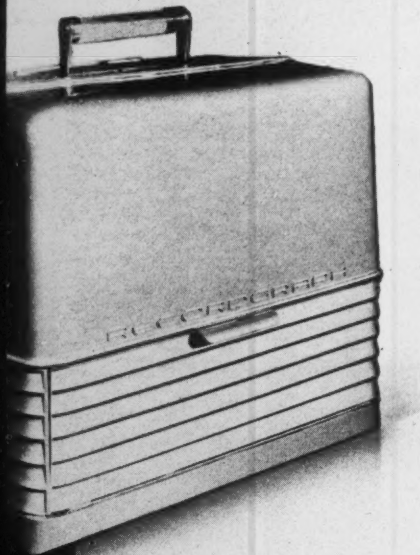
Brackets are often provided with adjustable features by coring attachment holes slightly larger than the screws which hold them, thus permitting slight changes in position parallel to the clamping face. The holes can be elongated if considerable adjustment in assembly must be provided. If a universal adjustment is required, two sets of holes on faces at right angles can be provided in a pair of castings. At the same time that holes for the screws are cored, others for dowel pins may be made.

The foregoing are only a few of many ways in which added benefits can be derived if the designer keeps in mind the problems the shop may encounter when the die casting is to be machined and assembled into a finished product. Other similar facts can be discovered by the alert designer.

Thanks are due to engineers of the International Business Machines Corp. for drawings included in this article and for the benefit of their experience in the utilization of die castings.

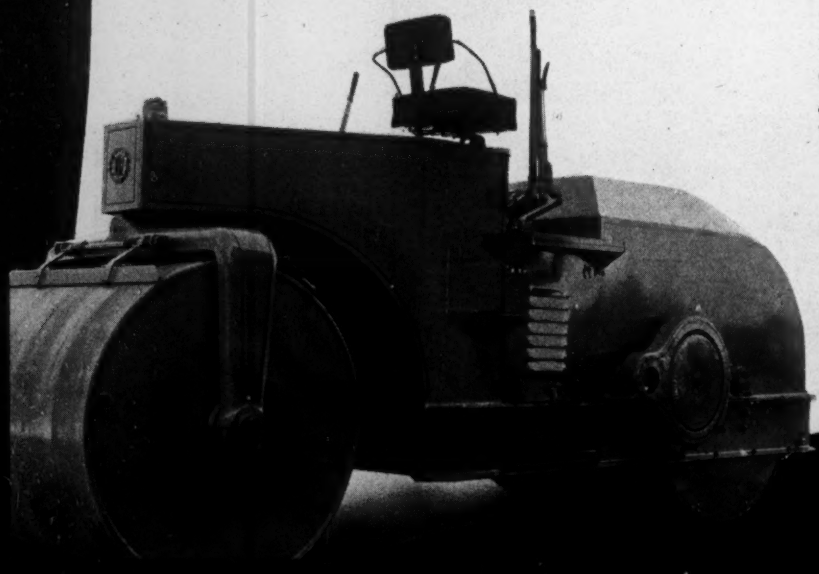


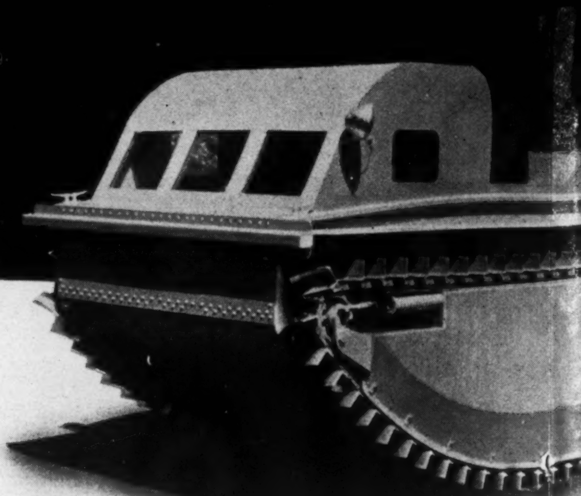
Position of the electrodynamic speaker in the Kadette radio (above) is unusual, in that the cabinet top is perforated and above it is a disk rigidly supported by a perforated steel grill. Sound flows upward, strikes the under side of the disk and is deflected outward in all directions over 360 degrees. Molded plastic housing of the radio, styled by Barnes & Reinecke, fully encloses a five-tube superheterodyne with built-in loop antenna



Use of different colored plastics to guide correct operation features the Wolf Recordgraph (left), color-styled by Howard Ketcham. When open for use, knobs of red, yellow, green and blue plastacele control the recording and reproducing movements of the soundtrack film. Background for these colors is provided by the chromium and gray lacquered exterior. Rolls of special film give a playing time of over ten hours

Main frame of Galion tandem roller (below) is all welded steel, and channel and plate members are rigidly cross braced. To eliminate former wear on inner edges of the front roll rims, hubs and yoke, the front roll now floats on four adjustable tapered roller bearings which permit assembly and maintenance with proper clearance between rims. Heavy duty transmission includes gears of alloy steel, accurately cut, machined and heat treated. Steering is finger-touch hydraulic





Land and water propulsion of the Roebling
obtained from an endless roller chain wit
duralumin cleats bolted on. Idler wheels ar
chain in the form of sealed roller bearings of
larger than the thickness of the chain. Motor
Mercury. The hull is duralumin and rivet
exclusively. Clutches and brakes are hy

Design Fea
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A Pictorial Presentation of Re
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(For new machine listing see pag

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Q2
INTERNATIONAL
Cutawl

Universal motor of the International Register Cutawl (above) has increased power to provide high speed and ample reserve for heavy cutting. Except for the motor, all moving parts are lubricated by wicks drawing lubricant from two reservoirs, with two additional wicks lubricating the motor bearings. Vibration is virtually eliminated by counterbalancing

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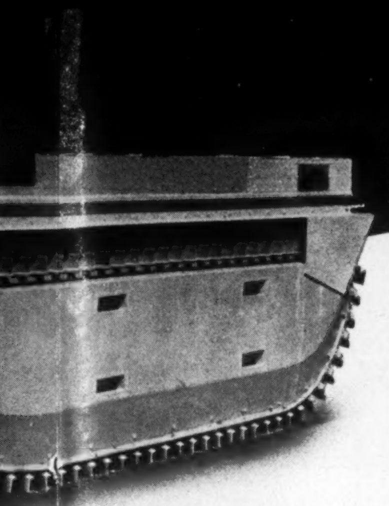

ebling Alligator (above) is
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rings of a diameter slightly
Motor is a 95-horsepower
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see page 104)

ONTH'S COVER. Reduction
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jects in the Dictaphone Cameo.
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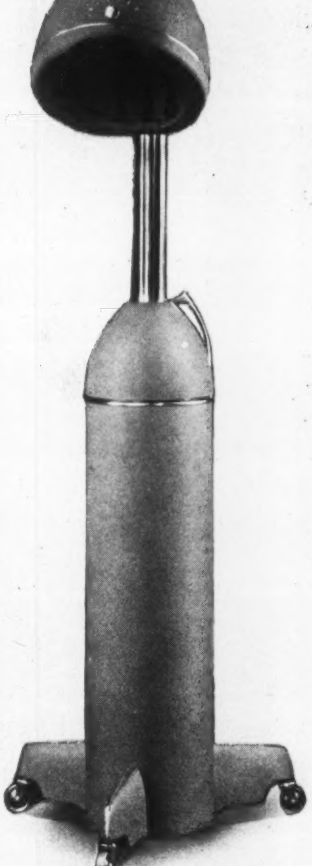
ping the field core so as to narrow
ons between poles. An automatic
switch turns on the motor as the
tube is lifted. Sensitivity of the
is increased by a counterweight
g force in only one direction

Wheelhead of the Cincinnati universal grinder (above) incorporates the new Filmatic spindle bearings, of multiple shoe construction, which are self-adjusting for variations in load. Bending moment from the load applied at the grinding wheel end and the driving sheave end of the spindle is reduced by mounting the wheel and sheave close to the front and rear bearings respectively. Table feed is actuated hydraulically and a new speed change device is built into headstock



A single stage die cast fan supplies air for fast operation of the Nestle hair dryer (left), styled by Egmont Arens. Customer comfort is aided by distribution of heated air through orifices in tubes, combined with expansion chambers between tubes and top exhaust ports. Air is filtered by impact on felt lining pads. Polymerin over gray gives a finish of unusual beauty which is also highly resistant to chemicals and abrasion

An oversize clutch in the Gardner-Denver portable compressor (below) permits easy cranking and warm-up of engine before it takes compressor load. Two-stage compression saves gasoline and insures operation well below carbonizing temperatures. To maintain even temperature for proper lubrication compressor cylinders are completely waterjacketed

Remington 285 bookkeeping machine (below) utilizes electricity for every operation, and has completely electrified numeral keys, alphabet keys, and carriage. All registers, vertical and cross-computing, are equipped with direct subtraction and are visible at all times. The machine automatically computes and prints, electrically, by solenoids

MACHINE
ditorial
DESIGN

Prestige of Designers Is Enhanced by Public Acclaim

PUBLIC recognition of designers and their work unfortunately is not an everyday event. Beyond the confines of engineering circles it was rarely that one saw, until recently, the credit for a new engineering achievement—particularly in the design field—placed actually where it belonged. In fact during the earlier half of the last decade a designer was just as likely to be criticized as praised if he developed, for instance, a new machine capable of performing mechanically a process previously accomplished by hand. The erroneous idea that machines created unemployment was still rampant in the minds of the public during that period.

It is fortunate for those engaged in design, and for engineers in general, that these concepts are changing; the pendulum is at last swinging back. Fewer and fewer references are being made in speeches or in print to the effect that the "machine age" is the stumbling block to the nation's progress. Instead, increased invention, research and design are being recognized as among the most essential steps needed to bring conditions back to normal.

More conclusive evidence of this could not be found than in the spontaneity with which the recent "Modern Pioneer" meetings have been received by both industrialists and the general public. These meetings, commemorating the hundred and fiftieth anniversary of the U. S. Patent system, are being held in numerous large centers throughout the country. At each of the celebrations a number of the most distinguished scientists, engineers and designers in the region are being honored as recipients of awards in recognition of their contributions to progress and well-being. Headed by Karl T. Compton, president of Massachusetts Institute of Technology, a national committee selected the men most qualified for this distinction.

Though the complete list of names is diversified insofar as branches of industry are concerned no difficulty is presented in picking from it the names of many men whose selection was based solely on outstanding contributions in the field of design. These men, ranking among the highest in the country in industrial achievement, deserve the plaudits of all designers as well as the recognition they are being accorded in the "Modern Pioneer" celebrations. By their individual accomplishments and by the prestige gained collectively for the design profession they have set an example that might well be studied and followed by all.

Professional Viewpoints

MACHINE DESIGN WELCOMES COMMENTS FROM READERS

" . . . commonly held error"

To the Editor:

IN THE January issue of MACHINE DESIGN is published an article entitled *Elliptical Gears Provide Feed Control.* The author describes an ingenious method for getting irregular motion. However, he mentions "with this large number of teeth we may expect three teeth always to be in contact." We believe this is a commonly held error.

If gears are cut 14½ degrees pressure angle with 28 teeth or more, there will be no difference in the number of teeth in contact regardless of how many teeth are cut. We believe 14½ degrees pressure angle will give about 1-1/3 teeth in contact; 20 degrees pressure angle will give about 1-1/10 teeth in contact.

The reason we pick 28 teeth as a minimum for 14½ degrees as an example, is this is approximately the smallest number of teeth where the undercutting due to the intereference of the cutter disappears.

—U. SETH EBERHARDT, Vice President
Newark Gear Cutting Machine Co.

" . . . . filter should protect pump"

To the Editor:

REFERRING to your recent article covering the application of filters to machines, there is only one sentence to which we would take exception. That occurs in the beginning of the second paragraph in the section subtitled "Two Full Flow Examples" where you state "In general, it may be said that a filter should not be put on the suction side of the oil pump. . . ." It has been our experience that in the case of machine tools that require a pump of the positive displacement type which will develop the vacuum characteristics necessary to lift lubricating oil or a coolant from a sump and deliver it to the parts to be lubricated or cooled, as the case may be, that the only reason for having a filter in the line at all is to protect the pump.

As you undoubtedly know, any positive displacement pump must have reasonably close clearances if it is to develop any vacuum characteristic at all, so consequently, any foreign matter that has to go through the pump before it is filtered out of the line would certainly have a very deleterious effect on the pump mechanism itself. In other words, if clean oil is delivered to the pump in the first place, it will deliver only clean oil. Of course, there are some instances, especially where installed with oil burners where it is also necessary to protect the burner tip as well as the pump and in installations of this type, it is common practice to put a discharge strainer in the line having a closer filtration medium than the suction strainer.

The foregoing remarks are all of a general nature and can be enlarged to make a sizable treatise on the subject.

L. E. MILLS
The Kraissl Co.

" . . . . flat diaphragms are best"

To the Editor:

IT IS recognized that greater accuracy can be obtained from special shapes of safety diaphragms such as those described in your September issue. However, there are applications where extremely close bursting limits are not required. For such applications as explosion relief devices in transformer tanks, a thin, flat disk, properly supported at the edges, is satisfactory.

When using a flat disk diaphragm, it is necessary to use material made to accurate specifications, with careful inspection and test of completed assemblies. It is possible to maintain bursting pressures between 10 and 16 pounds per square inch in a line of relief devices varying from 8 to 16 inches in diameter, by using micarta diaphragm thicknesses between .006 and .032 inches. Among the advantages of flat diaphragm over other types are: (1) Simplicity of diaphragm and mounting, (2) strength against positive or negative pressure, and (3) ease of crating, storage and handling.

—J. T. MERCEREAU
Westinghouse E. & M. Co.

Men of Machines

DESCENDANT of a long line of engineers and doctors, William Hewson Manning added another link to this chain by his recent appointment as assistant chief engineer in charge of design, Pontiac Motor division, General Motors Corp.

Born in 1901 at Baltimore, Mr. Manning attended Tome Preparatory school, University of Virginia, and received his engineering degree from Massachusetts Institute of Technology. In 1924 he joined Research Laboratories and in two years took an assignment from Buick, developing its first counterweighted and balanced crankshaft. After returning to Research Laboratories for a short period he became connected with Pontiac on special development work on engine design. Here he was transferred to the staff of Ben H. Anibal, Pontiac chief engineer, to work on special assignments. In 1932 he left Pontiac to become consulting engineer, returning to the company again as an assistant chief engineer.

WILLIAM H. MANNING

IN HIS new position as vice president and chief engineer of the recently formed Magnetic Engineering & Mfg. Co., Clifton, N. J., James L. Hope will be able to use the wide knowledge he has gained from experience in designing magnetic separators, magnetic clutches, and other special magnetic equipment.

Mr. Hope, a native of Junction City, Kans., received his technical training at Indiana, following which he taught a class of mechanical engineering at Chicago. He then became connected with Chicago Electric Co., and in October, 1919 joined Dings Magnetic Separator Co. As chief engineer of the latter concern, Mr. Hope designed various types of special magnetic equipment, and has many patents in his name. Numerous improvements in magnetic separators are the results of his research. Mr. Hope left Dings to become chief engineer and vice president of the new company.

JAMES L. HOPE

ADVANCEMENT of Howard A. Flogaus to the position of chief engineer, in charge of engineering on busses, trackless trolleys and street cars, for J. G. Brill Co., Philadelphia, is well earned as his entire career has been devoted to passenger car and engine engineering, and recently to motor coach engineering.

After fourteen years of experience in passenger cars and engine engineering, as well as sales engineering, Mr. Flogaus joined the motor coach division of General Motors Truck Co., Pontiac, Mich., in May, 1930. Finding motor coach designing extremely interesting he continued in this field, moving rapidly through various capacities in the coach division of Yellow Coach, until he was finally placed in charge of all drafting room activities. In 1937, Mr. Flogaus left General Motors to join Reo Motors Car Co., Lansing, Mich., where he was placed in charge of coach engineering. In

HOWARD A. FLOGAUS

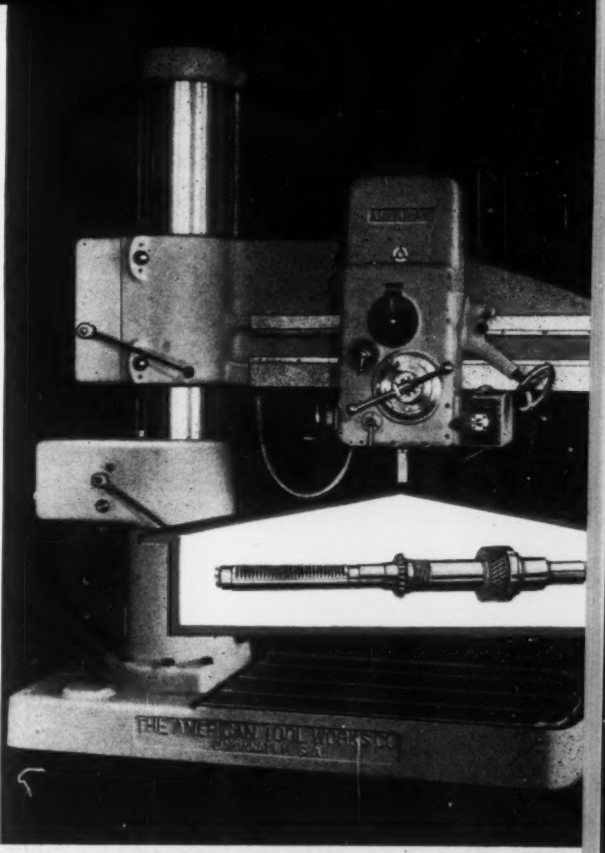
To Preserve Its ACCURACY

NITRALLOY

THE HARDEST KNOWN STEEL SURFACE FOR WEAR RESISTANCE!

. . . was used in important parts of "American Hole Wizard"

TWO of the most accurately machined pieces found in the operating head of this modern "American Hole Wizard" are the spindle and spindle sleeve, illustrated. To reduce the permissible allowance for the sliding fit of the spindle in the sleeve and to preserve the accuracy of the fit, it was essential that both pieces should be wear proof. The designers specified Nitrided Nitralloy, thereby not only minimizing wear but eliminating the danger of scoring and seizing as well. This is but a single example of the many phases of industry that have accepted Nitrided Nitralloy for their wear resisting parts! For information write The Nitralloy Corporation or any of its listed licensees.



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Republic Steel Corp. . . . . Massillon, O.
The Timken Roller Bearing Co. . . . . Canton, O.
Vanadium-Alloys Steel Co. . . . . Pittsburgh, Pa.

★ *A FEW TYPICAL APPLICATIONS* ★

- Calender Rolls
- Cams and Camshafts
- Chain Links and Pins
- Connecting Rods
- Crankshafts
- Cylinder Liners
- Die Casting Dies and Cores
- Fan Blades
- Fuel Injector Parts
- Gears
- King Pins
- Pinions
- Piston Rods and Rings
- Pump Rotors and Sleeves
- Push Rods
- Scale Balances
- Scale Blocks
- Seaming Rolls
- Seats for Valves
- Shackle Bolts
- Shafts
- Sockets
- Spindles
- Splines
- Sprockets
- Steering Worms
- Tappets
- Valve Gauges
- Valve Seat Rings
- Valve Stems and Sleeves
- Water Pump Shafts
- Worms
- Wrenches
- Wrist Pins

a short time he was made chief engineer of the company, and then vice president. Two years later he accepted the offer of assistant to vice president of the J. G. Brill Co., which position he occupied previous to his present appointment as chief engineer early this year.

◆

HAROLD J. STEIN, research engineer of the manufacturing department of Allis-Chalmers Mfg. Co., Milwaukee, has been appointed director of research, chemistry and metallurgy, of the company. His assistant will be J. T. JARMAN.

◆

HENRY A. LARDNER, since 1913 vice president of J. G. White Engineering Corp., New York, has been elected president of United Engineering Trustees, joint organization of civil, mining and metallurgical, electrical and mechanical engineers.

◆

JOHN I. YELLOTT has been named professor and director of mechanical engineering at Armour Institute of Technology, assuming the duties of the position left vacant by PROF. P. C. HUNTLY who will direct activities of the civil engineering department. The appointment of Mr. Yellott will become effective Sept. 1, 1940, with the consolidation of Armour Institute of Technology and Lewis Institute of Technology, under the new name of Illinois Institute of Technology.

◆

PAUL H. RUTHERFORD, chief engineer of Delco Products division of General Motors Corp., Dayton, O., has been made factory manager. EDWIN F. ROSSMAN, assistant chief engineer, succeeds Mr. Rutherford as chief engineer, and CALVIN J. WERNER becomes assistant chief engineer.

◆

HARRY E. SCHANK, identified with McCord Radiator & Mfg. Co., Detroit, since 1922, has been appointed chief engineer of the company. Mr. Schank who joined the company as research engineer was, previous to his present appointment, in charge of radiator design and development since early in 1928.

◆

HERBERT G. MOULTON has been elected president of American Institute of Mining and Metallurgical Engineers. Mr. Moulton is a consulting engineer in New York. ERLE V. DAVELER, vice president of Utah Copper Co., and W. M. PIERCE, chief of research, New Jersey Zinc Co., have been named vice presidents.

◆

EDWARD A. PRENTIS of Spencer, White & Prentis, New York, has been re-elected president of the American Standards association. R. E. ZIMMERMAN, vice president of U. S. Steel Corp., has also been re-elected vice president. R. P. ANDERSON, secretary of the division of refining, American Petroleum institute, has been elected chairman of the Standards Council; and H. S. OSBORNE, engineer in charge of operating results of American Telephone and Telegraph Co., vice chairman of the Standards council.

◆

ROBERT A. JONES, connected in various engineering capacities with General Electric Co., since his graduation, has been appointed district engineer of the New York territory. After completing the company's test course, Mr. Jones was a member of the industrial engineering department. W. S. HILL who since 1928 has been identified with the New York engineering department of the company, will assist Mr. Jones.

◆

A. N. COX, president of Pittsburgh Commercial Heat Treating Co., Pittsburgh, has been elected president of the Metal Treating institute.

◆

GEORGE J. MEAD was presented the Sylvanus Albert Reed award for 1939, conferred annually by the Institute of the Aeronautical Sciences in recognition of a notable contribution to aeronautical engineering. Mr. Mead, member of ASME and vice chairman of the National Advisory committee for Aeronautics, received the award "for the design and development of high-output aircraft engines for military and commercial services."

◆

R. W. SORENSEN, professor of electrical engineering and head of the department of electrical engineering, California Institute of Technology, has been elected president of American Institute of Electrical Engineers, New York.

◆

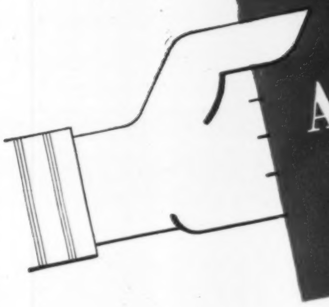
W. A. PARRISH has joined the engineering staff of Cummins Engine Co., Columbus, Ind. Mr. Parrish was previously connected with Caterpillar Tractor Co., as engine designer.

◆

KEITH T. DAVIS, who joined the L. J. Mueller Furnace Co., Milwaukee, in 1937 as assistant engineer, now becomes chief engineer of the company. Mr. Davis has been active in development of heating and air conditioning equipment.

◆

RAYMOND STEVENS, vice president of Arthur D. Little Inc., Cambridge, Mass., has been appointed director of a research survey in industry sponsored by the National Research council, New York. The National Research council is a co-operative organization of scientific men and includes representatives of engineering and industry.



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In keeping with our constant efforts to make available to our customers *better* products and better materials, our Mahwah, N. J. foundry is now manufacturing ***Meehanite*** *Castings.* ***Meehanite*** is the modern, metallurgically controlled cast iron which provides an array of superior engineering properties plus uniform, day by day dependability. Castings can be poured to *your* predetermined specifications.

Write us for further information and literature.

These 3 Free Bulletins explain the use of Meehanite for...

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Noteworthy PATENTS

Wraps and Ties Packages

PUTTING one or more wraps of twine about a package and tying a knot in the ends of the twine are the operations performed by an improved tying machine designed by Benjamin H. Bunn. The machine, for which the knot-tying mechanism is shown in *Fig.* 1, is covered by patent 2,182,959 and assigned to the B. H. Bunn Co., Chicago.

After twine is wrapped around a package with the starting end caught in the tying mechanism, a catch takes hold of the wrapping twine to form the knot. Pins in a slot move to carry the wrapping end of the twine and also the initial end beneath the beak of the knotter head. The lower jaw of this head is bell crank in form and its lower offset arm carries a roller which engages an annular cam face at the upper end of the boss in which the knotter shaft is journaled. The lower end of the shaft carries a pair of bevel gears by which the knotter head is rotated at the proper time. This assembly is pivoted and operable back and forth by a cam and the entire tying assembly slidably mounted on a plate.

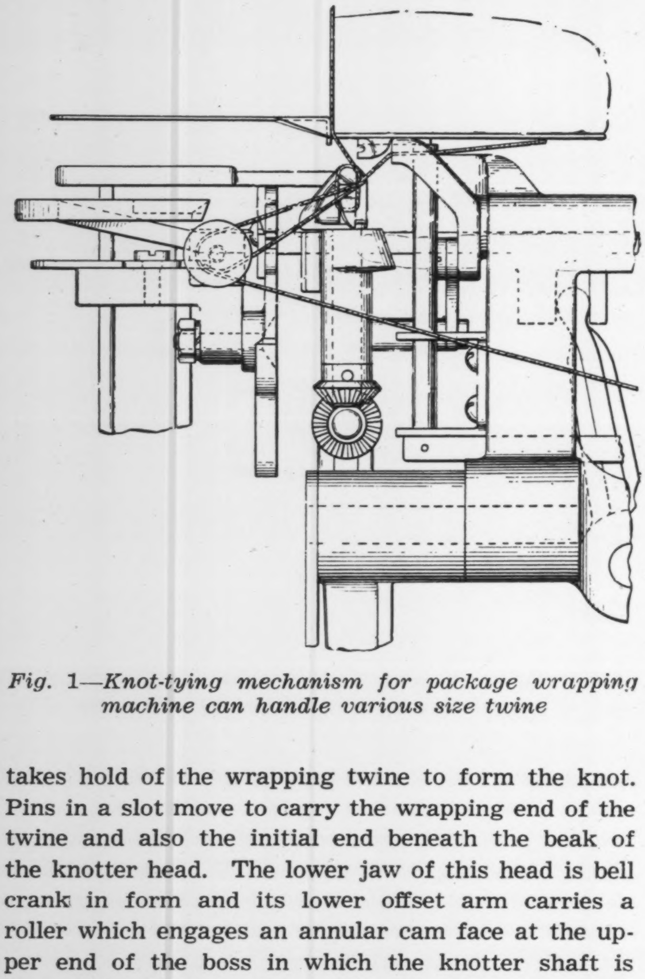


Fig. 1—Knot-tying mechanism for package wrapping machine can handle various size twine

Twine is pulled upwardly along side of the beak by a tip-up lever. Then as the knotter head rotates, the reaches of twine are wrapped, side by side about the beak. Jaws open to receive the twine. The next step pulls the twine within the jaws backwardly to form the loop of a twine knot. This action is effected by rocking the jaw backward with a stripper to strip the encircling twine.

As the loop slides off the jaws sufficient twine is available to pull through the loop as it closes up to form a knot. A cutter severs the twine, leaving a starting end engaged in the tying mechanism.

Provides Torque Regulation

CAPABLE of slight longitudinal movement dependent upon the amount of torque transmitted, the worm gear reduction unit shown in *Fig.* 2 may be employed as either a load limiting device or a constant torque unit. Designed by George H. Acker, this

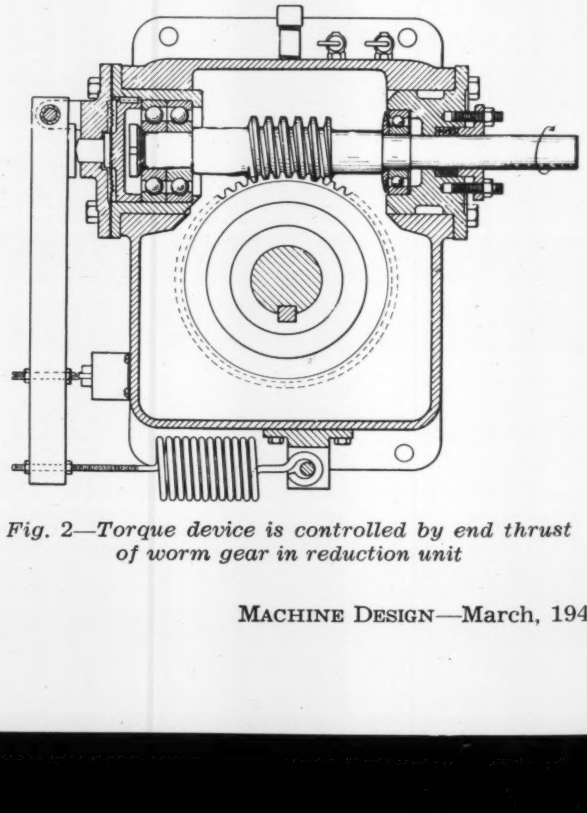


Fig. 2—Torque device is controlled by end thrust of worm gear in reduction unit

Each one ***labelled*** *to show strength and hardness...*

CERTIFIED GEARS ★

BRAUN
CERTIFIED GEARS
GEAR NUMBER
101
TENSILE STRENGTH
52,500
HARDNESS
20 ROCK-C
223 BHN
BRAUN GEAR CORP.
BROOKLYN, N.Y.
BRAUN

...*cast in* NICKEL *alloyed iron*

DEPENDABILITY is all-important to the designing or specifying engineer when selecting a gear and no gear is more dependable than the material from which it is made.

Braun Certified Gears are dependable. Made of a Nickel-chromium-molybdenum cast iron each gear is tested, labelled and guaranteed to provide a minimum tensile strength of 50,000 p.s.i. High hardness controlled within narrow limits reduces abrasive wear, preserves tooth contours and assures longer service.

The improved properties of Nickel alloy cast irons enable Braun gears to more successfully withstand abnormal loadings and stresses. Furthermore the uniformly high strength of this material permits redesigning for smaller gears and more compact assemblies.

Consultation is invited on your problems involving Nickel.

Typical minimum properties of Nickel-chromium-molybdenum cast iron used by Braun Gear Corp.:

Minimum tensile strength, p.s.i.	50,000
Compression strength, p.s.i.	150,000
Shear strength, p.s.i.	58,000
Torsional strength, p.s.i.	67,000
Modulus of elasticity	20,000,000
Torsional modulus elasticity	7,500,000
Transverse strength, lbs.	3,000
Transverse deflection, in. (test bar 1.2" diameter, 18" span)	0.04
Brinell hardness	220
Weight per cubic inch, lbs.	0.26

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET
NEW YORK, N. Y.

control method is covered by patent 2,175,047, assigned to the Cleveland Worm & Gear Co.

When used as a torque limiting device for protection against overloads, thrust on worm shaft is balanced by a lever and spring system. Spring tension holds this lever against end thrust of the worm shaft. As longitudinal thrust approaches an overload condition, the lever is moved outward to actuate an electric limit switch, thereby stopping the driving motor. In this manner overloads are prevented from causing any damage to gear unit or motor.

If applied as a torque regulating unit, the limit switch is double-acting and controls the operation of a reversible motor that actuates a variable speed transmission. When the load increases beyond its preset limit, the control switch closes the circuit to change the variable speed unit ratio, driving at reducing speeds until the system is again in balance. Likewise if torque load should be reduced, contact is made through the other circuit of the limit switch causing the variable speed drive to increase its speed. Thus the torque output will be held within limits.

Feeding Device Sorts Caps

CAP feeding devices for capping machines employ many methods for delivering caps right side up. The design illustrated in *Fig.* 3, however, utilizes a star wheel and finger arrangement for feeding caps into either of two chutes depending on their position, up or down.

Caps are positioned in a chute by a rotating disk and brush. As the caps engage the star wheel, a finger is supported by the top of the cap or allowed to fall into the cap depending on its position. If the cap is correctly positioned, the finger will be supported until the cap moves along into the delivery chute. If the cap should be upside down, however, the finger moves downward by action of a spring. Rotation of the star wheel then carries this cap from the first chute into a second where it is released from the finger by a cam action.

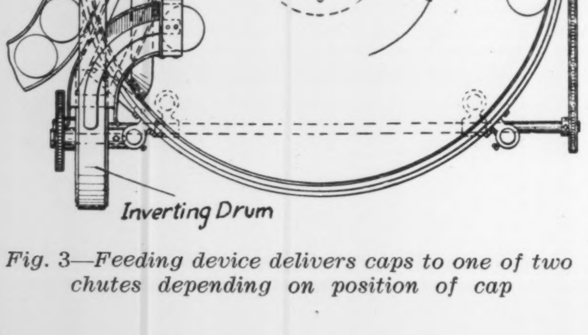


Fig. 3—Feeding device delivers caps to one of two chutes depending on position of cap

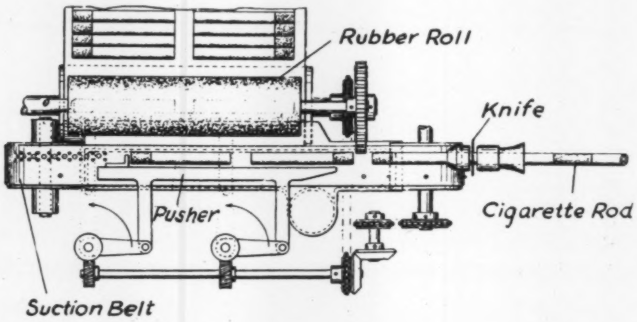


Fig. 4—Perforated suction belt registers cut cigarettes for transfer to delivery belt

When a cap has been carried into this position, it is moved along the auxiliary chute by the rotating disk. An inverting device consists merely of a rotating drum which picks up the caps at the bottom, discharging them at the top with right side up. If a second capping machine is employed this auxiliary chute feeds it direct. Otherwise, the caps are fed back into the bin, right side up.

In addition to selecting the caps, the star wheel also acts as a spacer for feeding caps to the machine and as a limiting device to stop movement of the caps should the delivery chute be full. Invented by William J. Mundy, the design of this feeder is covered by patent 2,176,659 and is assigned to C. T. Small Mfg. Co., St. Louis.

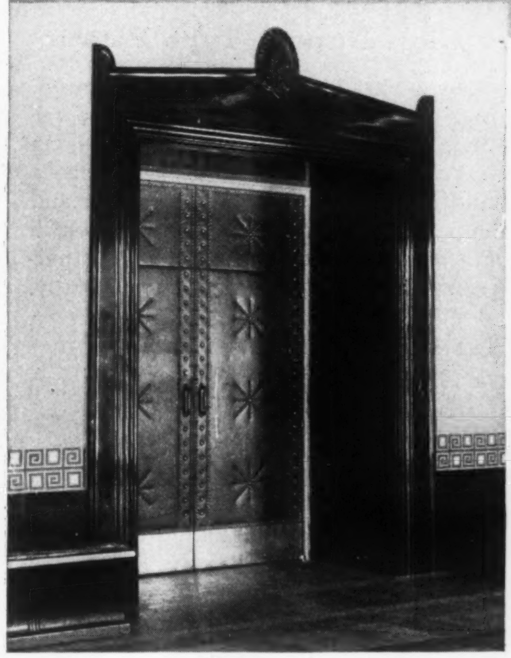
Suction Belt Spaces Cigarettes

SEPARATING cork-tipped cigarettes, cut from rod, without injuring them and transferring them to an endless delivery belt is effected by the catching mechanism illustrated in *Fig.* 4. Designed by Wilhelm B. Bronander, this device is covered by patent 2,176,485 and is assigned to American Machine & Foundry Co., Brooklyn.

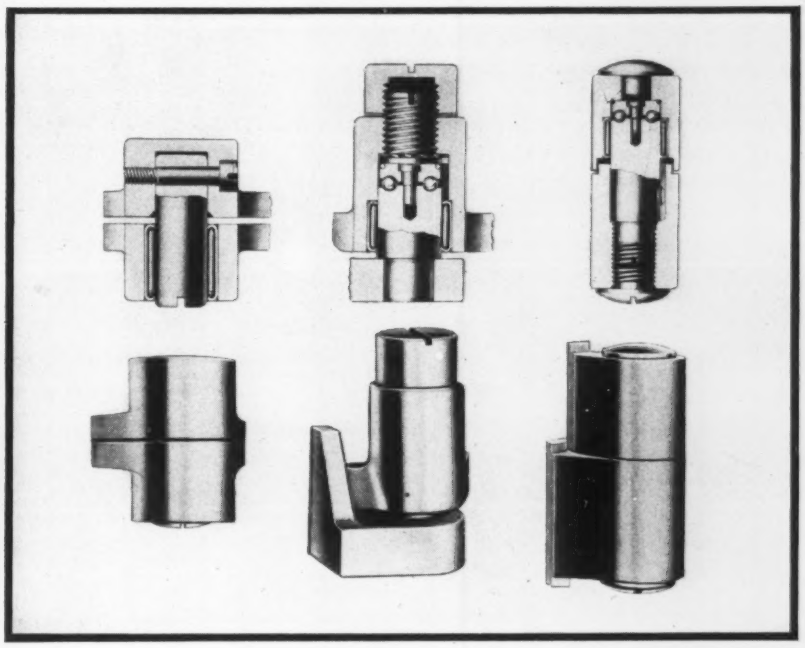
Cigarette rod issuing from a machine is cut to length by a knife and picked up on a perforated suction belt travelling faster than rod to space cigarettes. Registered by successive groups of perforations in the belt, they are forwarded endwise in front of a pusher. Operating by arms connected to parallel cranks on a vertical crankshaft, this pusher moves the cigarettes sidewise in pairs with tips at corresponding ends.

As the pusher operates, the cut lengths run between soft rubber rolls where their forward motion is stopped. Transfer then to the delivery belt is regular and spacing accurate because the pusher is accurately synchronized with the perforations on the belt and cigarette ends register with these spacings. Thus no damage is done to cigarette ends by the use of stops.

RUSSWIN HINGES SWING FREELY ON TORRINGTON NEEDLE BEARINGS



Russwin Anti-friction Pivot Hinges are designed for just such jobs as carrying these heavy ornamental doors, weighing up to 1000 pounds each.



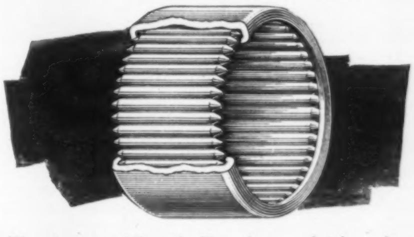
In these three types of pivot hinges, Russell & Erwin Manufacturing Co. combines Torrington Needle Bearings and ball bearings—the Needle Bearings to carry heavy radial loads in a limited space, the ball bearings to take the thrust. Note the compact designs obtained.

MINIMUM friction was the first requirement in the design of Russell & Erwin Manufacturing Company's Adjustable Ball Bearing Pivot Hinges. Because hinges involve both radial and thrust loads, the design utilizes both ball thrust and Torrington Needle Bearings—an interesting example of the adaptability of the Needle Bearing for use with other types of bearings.

"Torrington Needle Bearings were selected for the radial loads," say Russell & Erwin engineers, "because of their compactness, ease of assembly, lubricant retaining qualities, and their comparatively low cost. With them we were able to keep the knuckle diameters to an absolute minimum and to provide a truly anti-friction bearing capable of handling the heavy oscillating loads at very slow speeds, which the hinges are called upon to carry.

"We feel that Torrington Needle Bearings have assisted us materially in making a most distinct advance in pivot hinge design."

You can build better value into your own product by incorporating the



Torrington Needle Bearing—the bearing that gives anti-friction construction in small space at low cost, and needs little attention in service. The Torrington Engineering Department will be glad to cooperate with you in laying out applications for the Needle Bearing in your product. If you would like additional information on this unusual bearing, write for Catalog No. 9. For Needle Bearings to be used in heavier service, request Booklet 103X from our associate, the Bantam Bearings Corporation, South Bend, Indiana.

The Torrington Company
ESTABLISHED 1866
Torrington, Conn., U.S.A.

Makers of Ball and Needle Bearings

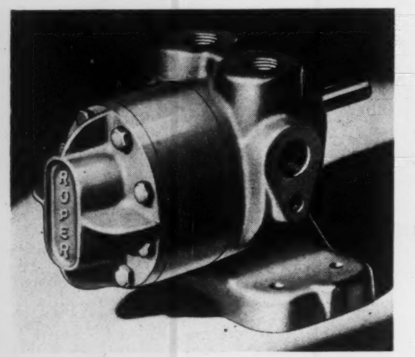
New York Boston Philadelphia Detroit
Cleveland Chicago London, England

TORRINGTON NEEDLE BEARING

New PARTS AND MATERIALS

Rotary Pump Line Contains 7000 Units

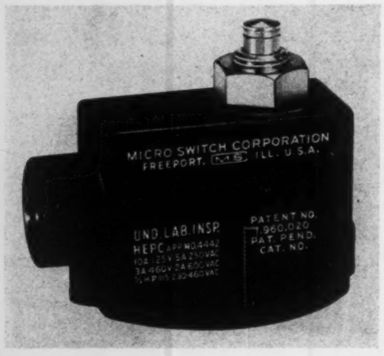
CONTAINING over 7,000 different units, a new line of rotary pumps has been announced by the Geo. D. Roper Corp., Rockford, Ill. The line includes pumps of 1, 3, 5, 10, 15, 20, 35, 50, 75, 100, 150, 200, 300, 500, 750 and 1000 gallons-per-minute capacities, at speeds up to 1800 revolutions per minute and against pressures up to 1000 pounds per square inch. At present 21 different drives and mountings are available ranging from ordinary foot, hub and flange mounting heads to complete bedplate units for direct motor drive; gear reduction; flat or V-belt drive. An outstanding feature of this line is "hydraulic balance." It equalizes internal pressure at all points and absorbs all shock or thrust from the power end of the drive shaft. Other features include a choice of spiral, spur or herringbone gearing; conventional packing box, spring loaded packing box or mechanical seal; sleeve or roller bearings.



Hydraulic balance which equalizes internal pressure at all points and absorbs shock is feature of rotary pump line of 7000 units

Switches Available in Die Castings

MICRO SWITCH CORP., Freeport, Ill., announces that its Micro switches are now available in a rugged, cleanlined housing of strong die cast metal, with either open or closed top. The bottom plate is easily removable for making connections, and terminals are strong and rugged and will accommodate No. 14 solid wire. The hub takes a standard ½-inch conduit.



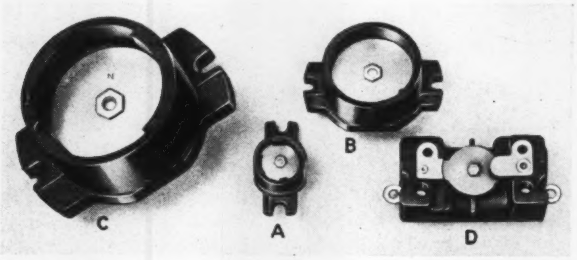
Rugged, cleanlined housing of die cast metal is now available on Micro switches

Announce High Impact Type Plastic

KNOWN as Durez 1900 Black, an easily preformed, high impact phenolic molding material is announced by Durez Plastics & Chemicals Inc., North Tonawanda, N. Y. It delivers an unusually smooth finish for a standard high impact type of plastic, and is unique in the particle size and shape through which it is given its excellent preforming properties. The particle size is so controlled that the material feeds easily.

Protect Motors at High Temperature

OVER-HEAT and overload protectors for single and polyphase alternating current motors are announced by the Spencer Thermostat Co., Attleboro, Mass. When built into a motor, one of these protectors automatically cuts the motor out of line the instant dangerous temperatures are reached within the motor, yet the safe peak operation of the motor is not limited in any way. Motors rated up to and including 3-horsepower are protected. These protectors are particularly recommended for unattended motors subjected to varying loads such as those in air conditioning equipment, stokers, circulators, blowers, oil burners, etc. Three standard sizes are offered, the ½-inch, 1-inch, and 1½-inch. In addition, there is a two-pole protector for certain types of fractional horsepower repulsion-start induction and capacitor motors.



Protector automatically cuts motor out of line when dangerous temperatures are reached within

Switch Cuts Power if Part Breaks

DEVELOPED originally for use on oil field equipment, a new type of power cut-out switch is announced by the International Derrick & Equipment division of the International-Stacey Corp., Columbus, O. The switch cuts off the source of power immediately upon any breakdown which disturbs the regular motion of the part upon which it is mounted. It consists

MAZLO
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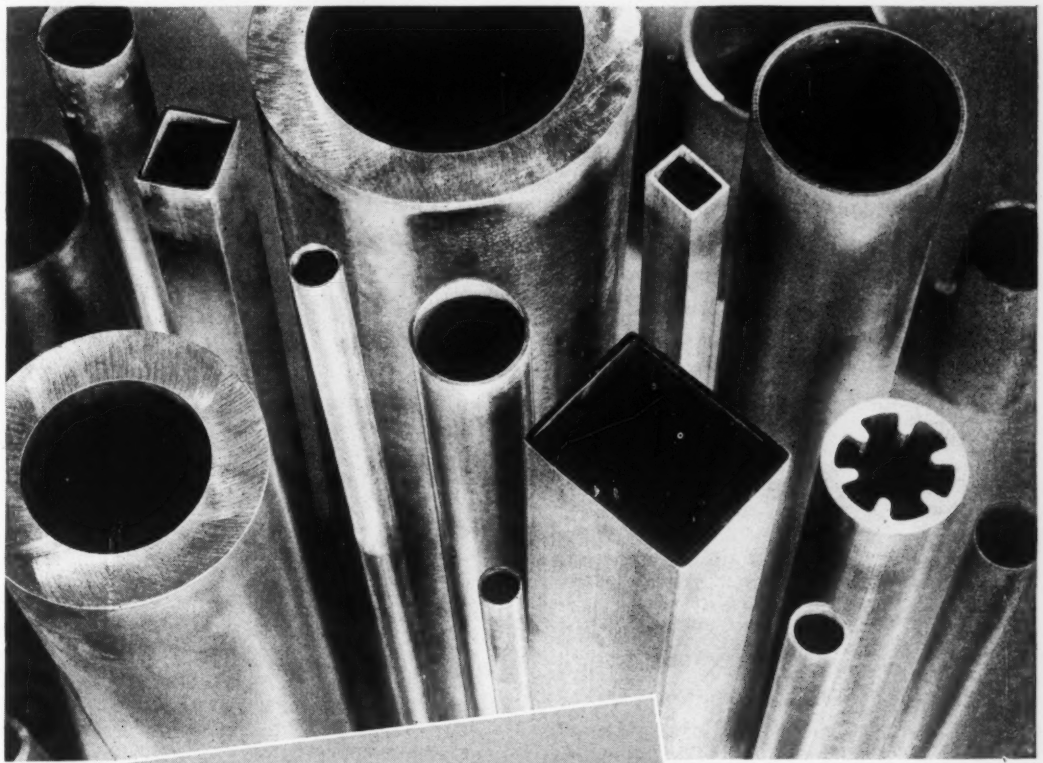
MAGNESIUM ALLOYS

THE LAST WORD IN LIGHTNESS



TUBING—To help you go very light

Thin-walled tubing or thick, round, square or irregular in shape, reinforced for still greater stiffness and strength; whatever your tubing need, you can get it in MAZLO Magnesium Alloys.

You benefit by the light weight of Magnesium, one-fourth that of iron. Made by the extrusion process, the metal in MAZLO tubing is placed just where it's needed; no excess weight. A minimum of finishing is required. It can be formed by standard metal-working methods and lends itself readily to assembly by riveting and welding. Its machining characteristics are unsurpassed.

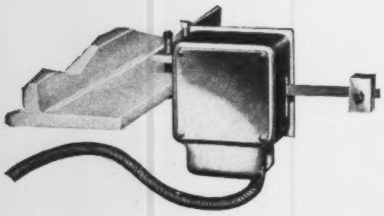
MAZLO manufacturing facilities offer Magnesium in every form; sand castings, permanent mold and die castings, extruded bar and shapes, sheet, tubing and forgings. Also in alloys providing a range of physical and fabricating characteristics.

MAZLO engineers have been dealing for years in the technical and economic aspects of achieving lightness. They will gladly assist you on problems of going very light economically. *Sales Agent:* Aluminum Company of America, 1703 Gulf Bldg., Pittsburgh, Pa.

MAZLO
Reg. U. S. Pat. Off.

AMERICAN MAGNESIUM CORPORATION

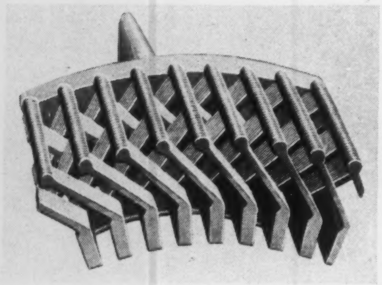
of a pivoted and weighted arm which is held in the operating position by means of a permanent magnet. When the force on the arm exceeds the force of attraction in the magnet, the arm drops by gravity and a mercury switch grounds the magneto in an internal combustion engine or de-energizes the magnetic switch of an electric motor. Sensitivity of the switch may be adjusted by moving the weight along the lever arm.



Source of power is cut off immediately by switch if any breakdown occurs in machine

New Type Rotor Announced

A NEW type rotor construction announced by General Electric Co., Schenectady, makes possible the use of cast aluminum rotors in the larger sizes of double squirrel cage motors for high starting torque, low starting current service. Called the "Valv-amp" rotor, it makes use of a unique shape of rotor slot and a special method of assembling rotor punchings to control the flow of starting current. As a result, without the use of a switch or other moving parts, current is permitted to flow in the outer squirrel cage when the motor is started, thus producing high starting torque. When the motor comes up to speed, current is allowed to flow through the entire rotor "winding," resulting in excellent running characteristics. In other words, the new rotor is said to permit the construction of larger cast-rotor motors which combine the advantages of the double squirrel cage motor and the conventional cast-rotor motor.



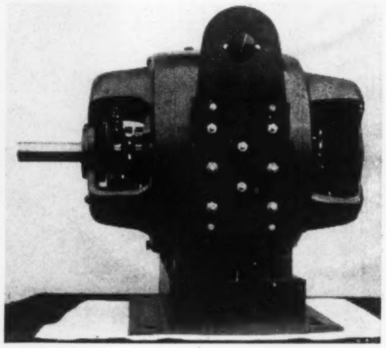
New rotor permits construction of cast-rotor motors combining advantages of double squirrel cage motor and conventional cast-rotor type

Joins Steels in Ingot Form

DIFFERING from monomelts, or single composition ingots, by making possible more than one composition or analysis in a single final ingot, the Pluramelt process for making steel is announced by Allegheny Ludlum Steel Corp., Pittsburgh. Through an electric furnace melting technique, special steels are melted and joined to low cost steels in ingot form. The composition of the special steels is controlled simply and within the ranges specified in commercial practice today, and may be changed, within limits, during the melting operation. Although experience thus far has been limited to Pluramelts of stainless alloys on soft or medium steel, and tool steel types on soft steel bases, it is likely that the process will be duplicated with any other alloy that can be melted in an electric furnace. The base metal can be covered on both sides and triple or more layers made of any desired proportionate thicknesses.

D-C Motors Furnish A-C Current

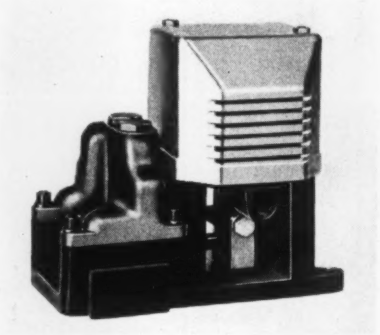
A LINE of direct current motors announced by Kato Engineering Co., Mankato, Minn., not only drives a piece of equipment but also furnishes 60-cycle alternating current for the operation of an auxiliary machine. For instance, machines requiring alternating current, like spot welders, can be operated in areas where only direct current is available. Other suggested applications for these motors include relays and controls, synchronous motors and fluorescent type lamps.



Alternating current for operation of auxiliary machine is provided by direct current motor

Valve Gives High Welding Speeds

ROSS OPERATING VALVE CO., Detroit, has announced a special model solenoid-operated air valve which was built to meet demands for high speed operation of welding guns. Although it is claimed this new valve has operated at considerably higher speeds on experimental work, it is now regularly delivering 400 welds a minute on production jobs.

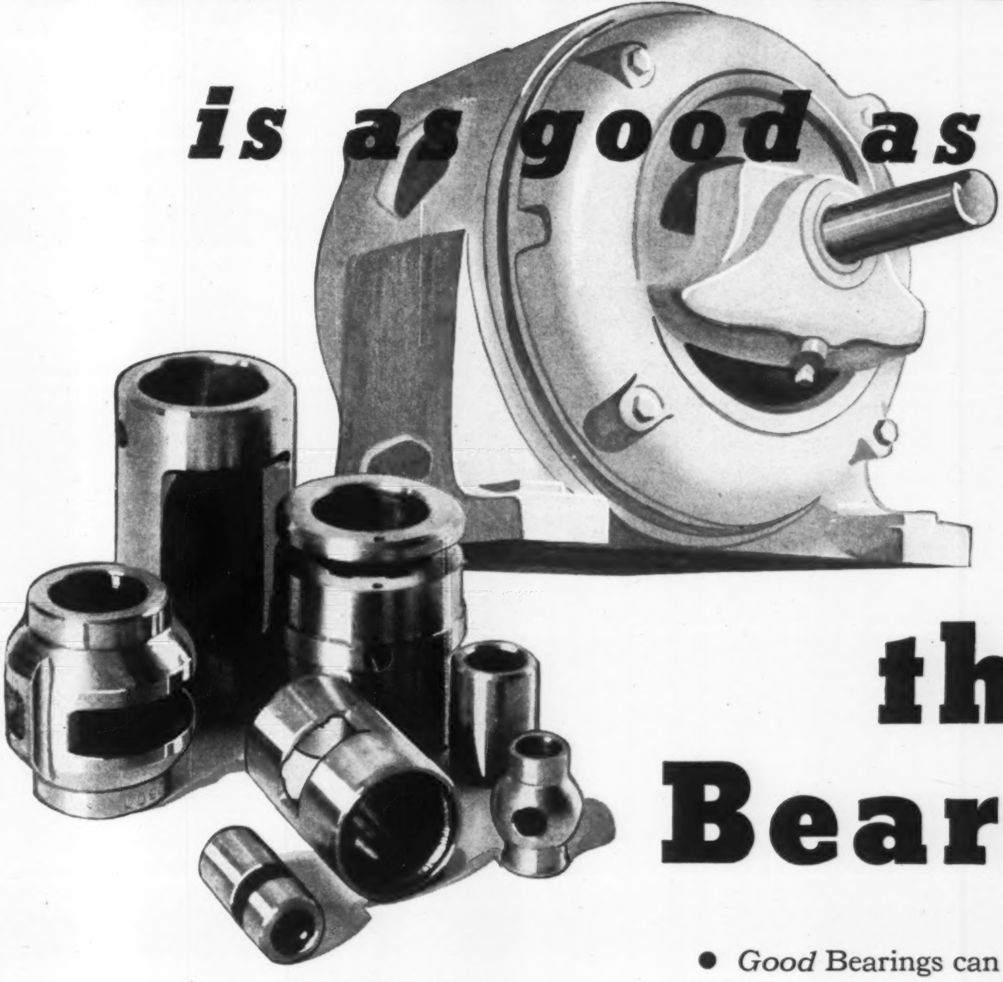


Four hundred welds a minute on production jobs are delivered by special model air valve for high speed welding

Develop Remote Control for Drive

PROVIDING an accurate, simple means for selecting the desired operating speed of a Varidrive motor when the latter is mounted beneath or above the driven machine or is otherwise inaccessible, a new single, right-angle mechanical remote control for Varidrive motors has been developed by U. S. Electric Motors Inc., 200 East Slauson avenue, Los Angeles. The Varidrive control shaft may be extended at a 90-degree angle in any one of eight different directions, an en-

Your Product is as good as the Bearings



NEW!

Sleeve Bearing Data Sheets for your file folder. Containing a wealth of information for all users of bearings. Write today for your **FREE** copy.

- *Good* Bearings can be a vital sales point for your product. When you can safely guarantee performance — long hours at top speed — years of trouble-free operation — your sale is in the bag.

Such a guarantee is entirely possible. Bring your application to us. Permit us to make a thorough study of *all* the operating conditions. We will gladly match our time against yours without obligation. Every bearing recommendation we make is based strictly on facts.

As manufacturers of EVERY type of bearing, we concentrate on the correct answer to every problem and eliminate all prejudice. So, if you want to improve your product, permit us to improve your bearings.

The most complete SLEEVE BEARING SERVICE in the world

JOHNSON BRONZE COMPANY
Sleeve BEARING HEADQUARTERS
525 SOUTH MILL STREET • NEW CASTLE, PA.

A NOTE

TO REMIND YOU

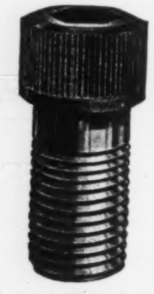
KNURLED

UNBRAKO

SOCKET HEAD
CAP SCREWS

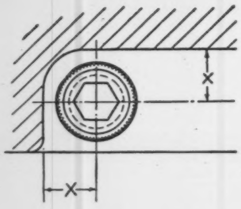
Save Clearance,
Material, Weight, Cost

Fig. 1434
Pat's. Pend.

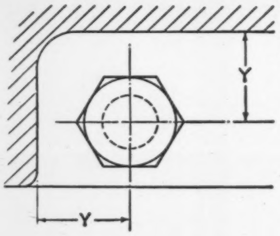


Knurled "Unbrako" Socket Head Cap Screw with the "Better Gripping Head"

The plan view below illustrates how simple it is to use much narrower and therefore thinner flanges without sacrificing strength.



See how the Knurled "Unbrako" snuggles right into the corner.



Notice the great open spaces necessary for the hex head and wrench.

This greater compactness of design means decided savings, increases holding power by bringing the screw head closer to the joint and makes for much greater neatness.

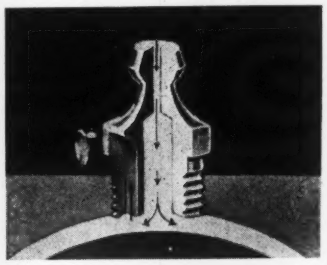
If these advantages are not already incorporated in your products, specify "Unbrako" for them all. Write to us for samples and literature.

STANDARD PRESSED STEEL CO.
JENKINTOWN, PENNA.
BOX 102
BRANCHES
BOSTON
DETROIT
INDIANAPOLIS
BRANCHES
CHICAGO
ST. LOUIS
SAN FRANCISCO

closed set of helical right-angle gears making this possible. This right-angle remote control permits the handwheel to be placed within easy reach of the operator so that the exact desired speed can be maintained without difficulty at all times.

Fittings Prevent Over-Lubrication

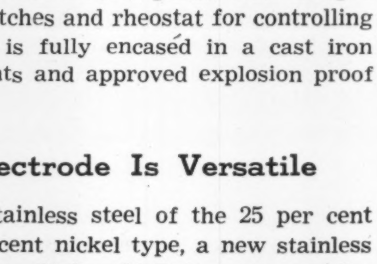
TO PREVENT over-lubrication of ball and roller bearings a new line of fittings and bushings for industrial machinery, known as Lubriguards, is announced by the Alemite division, Stewart-Warner Corp., Chicago. The fitting is installed directly into the bearing. In operation, with an Alemite hydraulic-type pressure gun applied to the fitting, the lubricant is forced through an inlet of the fitting and thence into the bearing. When a predetermined amount of back pressure is developed in the bearing, excess lubricant appears at the vent to signal that further lubrication is inadvisable.



Installed directly into the bearing, new line of fittings prevents over-lubrication of machines

Explosion-Proof Vibrator Added

AN EXPLOSION proof model, for use in plants where atmospheric conditions are highly flammable or explosive, has been added to the line of vibrators made by the Syntron Co., 260 Lexington avenue, Homer City, Pa. The vibrator, a heavy, pulsating electromagnet, is fully encased in a thick, electric-furnace steel case, with ground joints and an armored cable lead. The remote electric control panel, containing a rectifier, operating switches and rheostat for controlling the vibrator's power, is fully encased in a cast iron case, with ground joints and approved explosion proof fittings.



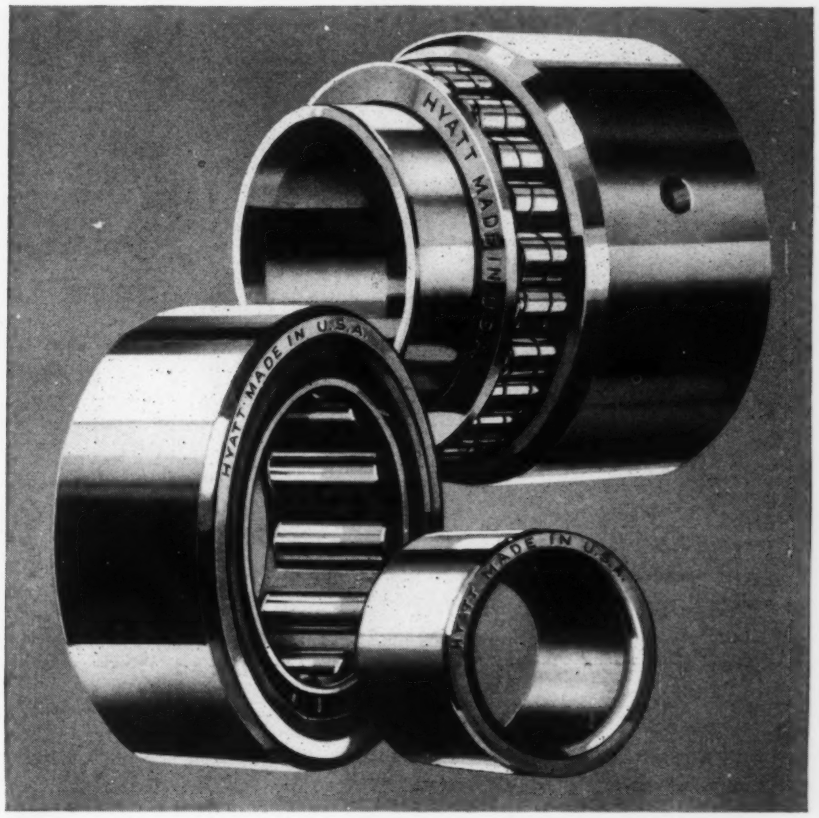
A heavy, pulsating electromagnet vibrator is designed for use in highly flammable or explosive conditions

Stainless Electrode Is Versatile

FOR arc welding stainless steel of the 25 per cent chromium, 20 per cent nickel type, a new stainless steel electrode known as Stainweld D is announced by the Lincoln Electric Co., Cleveland. It can also be used for welding various stainless steels to mild steel and

Longer Equipment Life

. . . Freedom From Care



HYATT WOUND ROLLER TYPE and HY-LOAD SOLID ROLLER BEARINGS shown opposite. Inherent design advantages, uniformity and accuracy along with their capacity for heavy loads account for the widespread application of these better bearings.

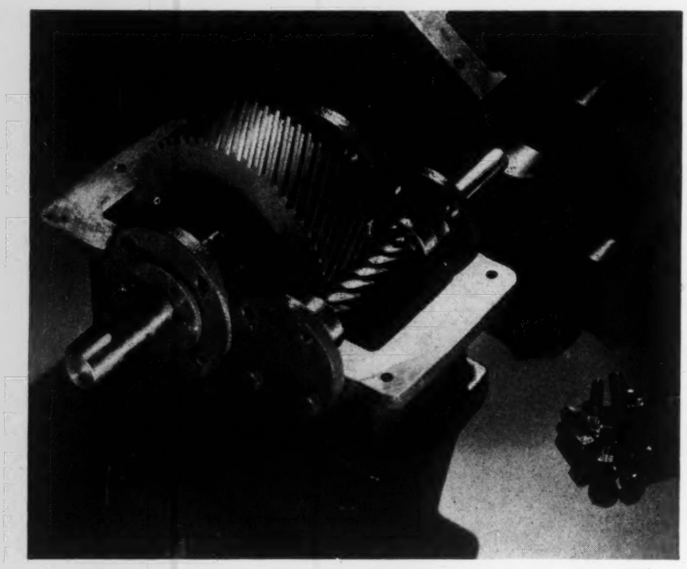
On and on it goes . . . equipment of every description . . . a symphony of mechanical smoothness . . . with gears, shafts, and wheels turning silently, accurately, effortlessly on Hyatt Roller Bearings. Long-lived, carefree bearings that serve so faithfully year after year . . . that help the machine builder to better serve his customers. Are you using Hyatts? If not, is there any information you desire? Hyatt Bearings Division, General Motors Sales Corporation, Harrison, New Jersey; Detroit, Chicago, Pittsburgh and San Francisco.

HYATT

ROLLER BEARINGS

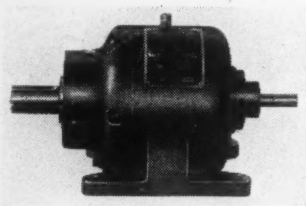
QUIET

SPEED REDUCERS
FOR EVERY NEED



No. 700 and 800 Helical Gear Type

THE country's oldest specialists in speed reducing equipment offer you, in addition to a time-tested and complete line, over 20 years of experienced engineering service . . . at your disposal, without obligation!



No. 7
WHS Differential
Speed Reducer

WHS
SPEED
REDUCERS

In a variety of types that cover the range from fractional to 75 H.P.,—ratios from 2-1 to 20,000-1. Many WHS Speed Reducers have been in continuous use for 5, 10 even 15 years!

Get our low prices
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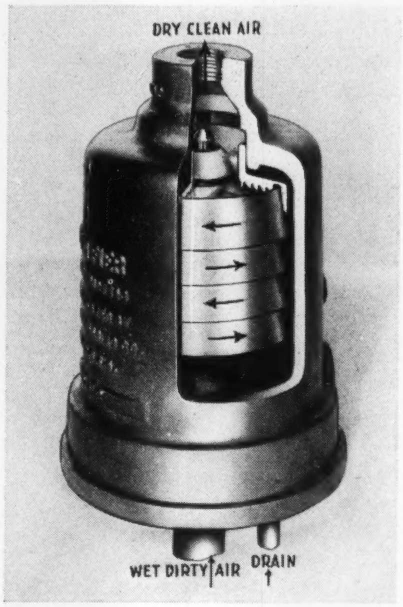
WHS Vertical
Motorized
Speed Reducer

WINFIELD H. SMITH, Inc.
A Speed Reducer for Every Application
16 ELTON STREET, SPRINGVILLE, ERIE COUNTY, N. Y.

for welding of steels which are air hardening and cannot be heat treated after welding, such as armor plate.

Airidifier Line Now Complete

FOR removing moisture and oil from air and gas line, the line of Aridifiers made by the Logan Engineering Co., 4912 Lawrence avenue, Chicago, is now complete in all sizes from ⅜ to 10 inches. Foreign matter impinges on a multiplicity of "propeller blades" revolving in opposite directions and propelled by the flow of air or gas. The arrested contamination and moisture is collected in the lower housing from where it is drawn off.

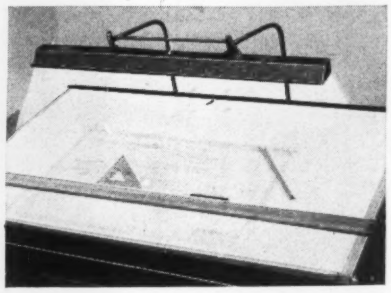


Foreign matter impinges on propeller blades in line of Aridifiers and is collected in lower housing

Engineering Dept. Equipment

Table Light Uses Fluorescent Bulb

USING a fluorescent bulb, a new table light for drafting rooms is announced by the Hamilton Mfg. Co., Two Rivers, Wis. Under this light, colors can be matched accurately as though it were daylight and because the fluorescent light is cool, with less glare, considerable added comfort is provided. The light is built into a 44-inch long reflector so it can cover the entire drawing table surface. In its central position the light provides 100 foot-candles of light directly underneath it and not less than 50 foot-candles at the



Built into a reflector to cover the entire drawing table surface, new table light matches daylight colors

CENTURY ELECTRIC COMPANY ST. LOUIS MISSOURI

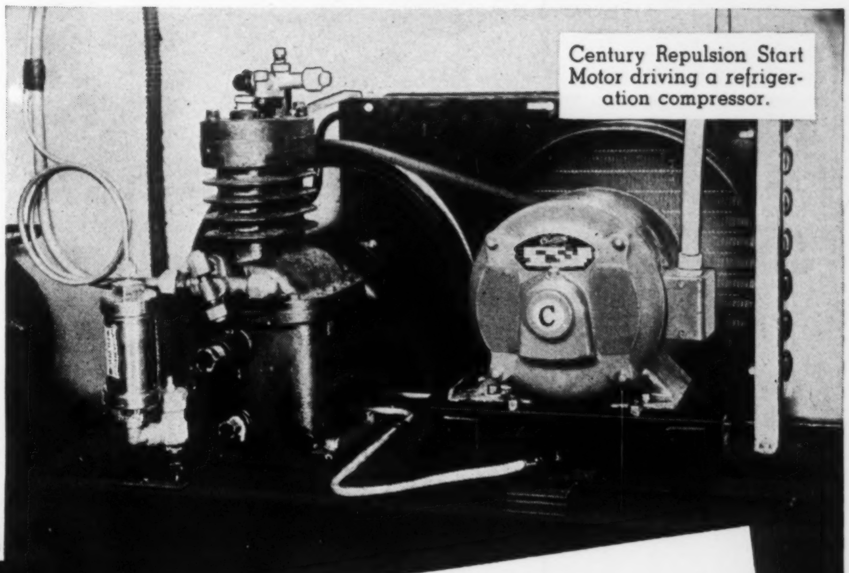
Century

REPULSION START INDUCTION

Brush Lifting

SINGLE PHASE MOTORS

The Repulsion Start Induction Single Phase Motor has Starting and operating advantages which cannot be obtained from any other type of Single Phase Motor.



Century Repulsion Start Motor driving a refrigeration compressor.

Get This New Free Bulletin! Find Out How Century Type RS Motors Improve Compressor Performance

IT WILL pay you to obtain your copy of this new Century Bulletin which describes the operating characteristics and construction details of Century Single Phase Repulsion Start Induction Motors. It tells why this type of Century Motor is ideally fitted for refrigeration compressor applications, how it assures the efficient performance of your installations.

Century Repulsion Start Induction Motors have starting and operating advantages which cannot be obtained from any other type of single phase motor. They fully meet the demands of compressor installations where high starting torque, low starting current and automatic starting are desirable.

This new bulletin contains charts and curves explaining the high starting efficiency of these Century Motors, showing why this factor is so important when driving refrigeration or air conditioning compressors.

It explains the ventilating system which keeps motor cool; why Century bearings have unusually long life.

In short, it tells you why Century Repulsion Start Brush Lifting Motors give such unusually dependable service on the toughest, hard to start jobs.

Century RS Single Phase Motors built in sizes of 1/8 to 40 H. P.

Write for your copy of Bulletin 402-E today. It's yours for the asking and contains much valuable information to help you in your business. Complete details on the entire Century line of single phase, three phase and direct current motors, from fractional to 600 H. P. will gladly be furnished by Century's national sales organization. A call will place the nearest Century Motor Specialist at your service.

CENTURY ELECTRIC COMPANY

1806 Pine Street St. Louis, Missouri

Offices and Stock Points in Principal Cities

Century MOTORS

One of the Largest Exclusive Motor Manufacturers in the World

BORED AND HONED CYLINDERS

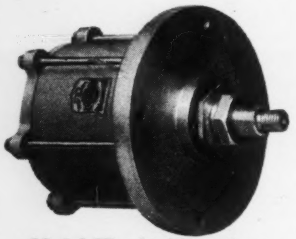
Mean Better Performance

Honed bore of a 16 in. x 7 ft. cylinder

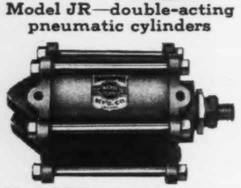
Hannifin Pneumatic Cylinders, including even the largest sizes, are bored and then honed on special Hannifin long stroke honing machines—a better finish that means better cylinder performance.

With the simple outside adjustment of the piston packing, the original high efficiency piston seal can be easily maintained. The soft, graphite-treated piston packing, and the straight, round, perfectly smooth cylinder bore prevent leakage and waste of air power, and cut friction loss to the minimum.

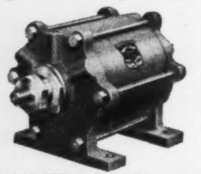
Hannifin air cylinders are built in a full range of standard mountings, sizes 1½ to 16 in. diameter, for any length stroke. Both single and double acting types available with or without air cushion. Write for Bulletin 34-MD with complete descriptions of all types.



Model JR—double-acting pneumatic cylinders



Model BR—double-acting pneumatic cylinders



Model CR—double-acting pneumatic cylinders

HANNIFIN MANUFACTURING COMPANY
621-631 South Kolmar Avenue, Chicago, Illinois

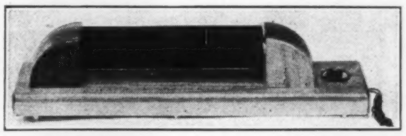
Engineers • Designers • Manufacturers
Pneumatic and Hydraulic Production Tool Equipment

HANNIFIN
PNEUMATIC CYLINDERS

extreme edges of the board. In addition the lamp is adjustable so that it can be moved wherever desired, or out of the way entirely. A trough on the front edge of the reflector may be used for pencils, triangles, and other instruments. The Hamilton company has also announced its No. 417 chair, designed especially for use with its Auto-Shift tables. Swivelling easily, the chair is mounted on rubber casters and finished in olive green. Its back rest is adjustable.

Desk Blueprinter Announced

PROVIDING a convenient, compact machine for making blueprints of drawings or other documents, the Baby Blue desk unit is announced by the Vandenwood Co., 2900 Euclid avenue, Cleveland. Weighing only 15 pounds, the unit is eight inches wide and 34 inches long. Source of light is a 20-watt tubular lamp, and the unit may be used on any 110-volt light circuit, alternating current, although direct current units are available. Printing time begins at one minute fifteen seconds and depends on the speed of the sensitized paper used and the quality of the tracing. In operation, sensitized paper and the original tracing are placed around the cylinder, the wrap-around curtain is pulled tight and fastened, and the time switch turned on.



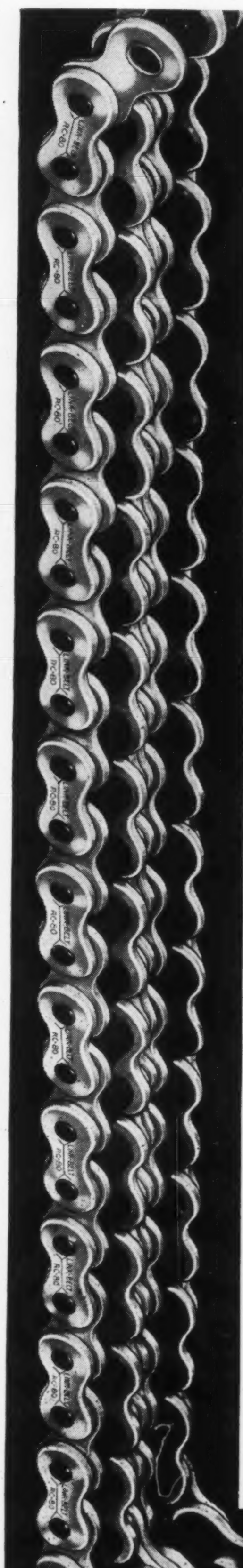
Small blueprinter weighs only fifteen pounds, permits making blueprints on desk

Printer Produces Drawings in Quantity

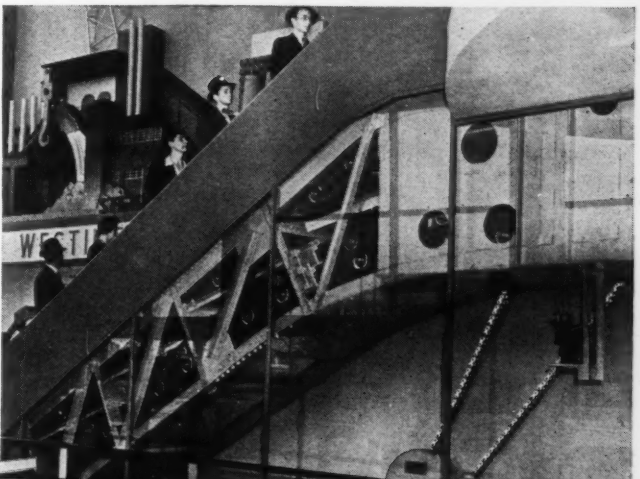
PRODUCTION of duplicate copies of line drawings in quantity is possible with the mimeograph photochemical printer announced by A. B. Dick Co., Chicago. The method depends on a brilliant new light source. After exposure to this light, any opaque drawing on translucent cloth or paper can be transferred to a sensitized stencil sheet. The stencil is then developed and placed in the mimeograph duplicator for accurate black and white reproduction in quantity. Time of the procedure from finished tracing to finished copies is generally less than 25 minutes.

Ink Stand Fills Pens, Saves Time

AN INK stand for filling ruling pens which saves considerable time and ink is announced by the Eugene Dietzgen Co., Chicago. It consists of three parts, a stand which holds the regulation ¾-ounce bottle of ink; a dipper arm which closes the bottle tightly when not in use; and a finger touch lever which raises a filling loop on the end of the arm from the bottle. The engineer simply lifts the pen from his work, reaches out, presses the lever with his little finger and touches the pen-nibs to the loop. A rubber stopper on the dipper arm seals the bottle against evaporation. The loop may be lowered or raised according to the level of ink in the bottle, and the stand is nontippable.



What Design Engineers are doing with SILVERLINK ROLLER CHAIN!



DELLINGER
DELLINGER
HAMMER MILL

ELECTRIC STAIRWAY ↑

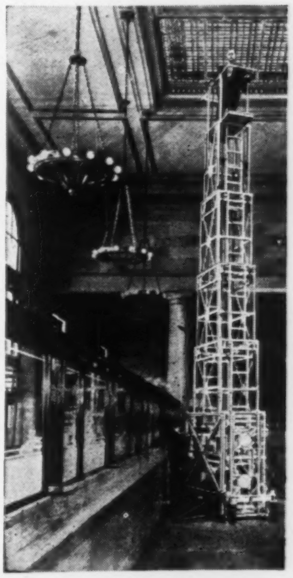
by Westinghouse, built to show World's Fair lookers how wheels go around, reveals Silverlink Roller Chain drives on the job.

"JACK-IN-THE-BOX"

portable elevator telescopes up to 35 feet to wash ceilings. Revolvator Company picked Silverlink for the hoist. ↓

← **FEED GRINDER**

modernized to suit alert millers by Dellinger Mfg. Co., gets smooth high speed and big capacity with Silverlink roller chain drives.



ON A THOUSAND NOTEWORTHY JOBS—tricky...difficult...unusual and commonplace—design men are solving many conveyor and drive problems with Silverlink Roller Chain. They appreciate the certainty of eliminating guesswork with its proven performance. Its definite economy helps them cut costs. It lasts long. It has "eye appeal"—enhances the appearance of any machine. Make use of Link-Belt's vast experience in solving design problems. Let us send you Engineering Data Book No. 1757.

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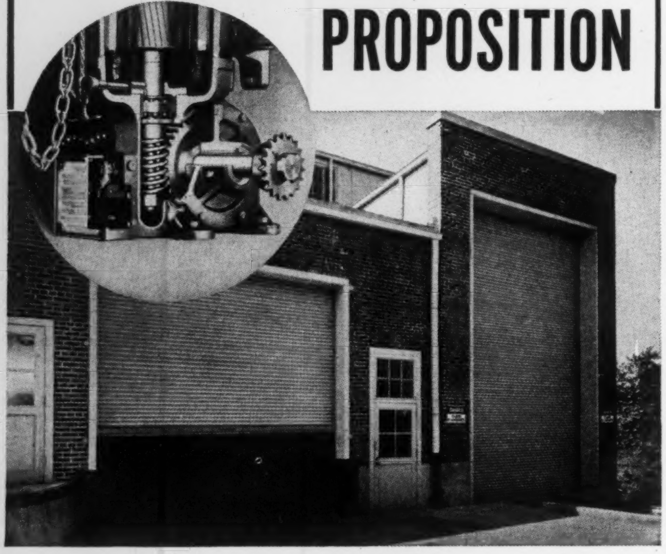
Silverlink **ROLLER CHAIN**

An "open and shut" **PROPOSITION**



• Architects, engineers and building owners throughout the world naturally look to Kinnear for doors that afford maximum protection with quick, easy, economical operation.

To insure that confidence, Kinnear engineers take more than ordinary precautions in selecting every part of the Kinnear operating mechanism.

That's why we take pride in supplying such a vital part as the worm and gear drive shown above.

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OHIO GEARS

Meetings and Expositions

March 6—

American Society for Testing Materials. Regional meeting to be held at Statler Hotel, Detroit. C. L. Warwick, 260 South Broad street, Philadelphia, is secretary.

March 6-9—

Industrial Tools & Equipment exhibition to be held at Bridgeport, Conn. Sponsored by Bridgeport Tool Engineers association, State Armory, 1494 Main street, Bridgeport, Conn. Further information may be obtained from R. T. Phipps, 271 Grovers avenue, Bridgeport, Conn.

March 7-9—

American Society of Tool Engineers. Third annual meeting to be held at Hotel New Yorker, New York. Ford R. Lamb, 2567 West Grand boulevard, Detroit, is executive secretary.

March 11-14—

American Society of Bakery Engineers. Annual meeting to be held at Edgewater Beach hotel, Chicago. Victor E. Marx, 1541 Birchwood avenue, Chicago, is secretary.

March 14-15—

Society of Automotive Engineers. National aeronautic meeting to be held at Washington hotel, Washington. John A. C. Warner, 29 West Thirty-ninth street, New York, is general manager.

March 28-29—

Society of Automotive Engineers. National transportation and maintenance meeting to be held at Mellon institute auditorium, Pittsburgh. John A. C. Warner, 29 West Thirty-ninth street, New York, is general manager.

April 1-2—

Association of Iron and Steel Engineers. Annual spring engineering conference to be held at Cincinnati. Brent Wiley, 1010 Empire building, Pittsburgh, is secretary.

April 7-13—

American Ceramic Society. Annual meeting to be held in Toronto. Ross C. Purdy, 2525 North High street, Columbus, O., is secretary.

April 8-12—

American Chemical Society. Semiannual meeting to be held at Cincinnati. Further information may be obtained from Dr. Charles L. Parsons, 728 Mills building, Washington, secretary.

April 9-10—

Armour Institute of Technology. Annual Midwest Power conference to be held at Palmer House, Chicago. Additional information may be obtained from the institute upon request.

April 10-11—

International Acetylene association. Fortieth annual convention to be held at Schroeder hotel, Milwaukee. Additional information may be obtained from the association headquarters, 30 East Forty-second street, New York.

April 18-19—

National Petroleum association. Semiannual meeting to be held at Hotel Cleveland, Cleveland. M. C. Mallon, 930 Munsey building, Washington, is secretary.

May 1-3—

American Society of Mechanical Engineers. Spring meeting to be held at Bancroft hotel, Worcester, Mass. C. E. Davies, 29 West Thirty-ninth Street, New York, is secretary.

May 6-8—

Machine Tool Electrification forum. To be held at Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Additional information may be obtained by writing Hendley N. Blackmon, at the Westinghouse company.

June 9-14—

Society of Automotive Engineers. Summer meeting to be held at White Sulphur Springs, W. Va. John A. C. Warner, 29 West Thirty-ninth street, New York, is general manager.

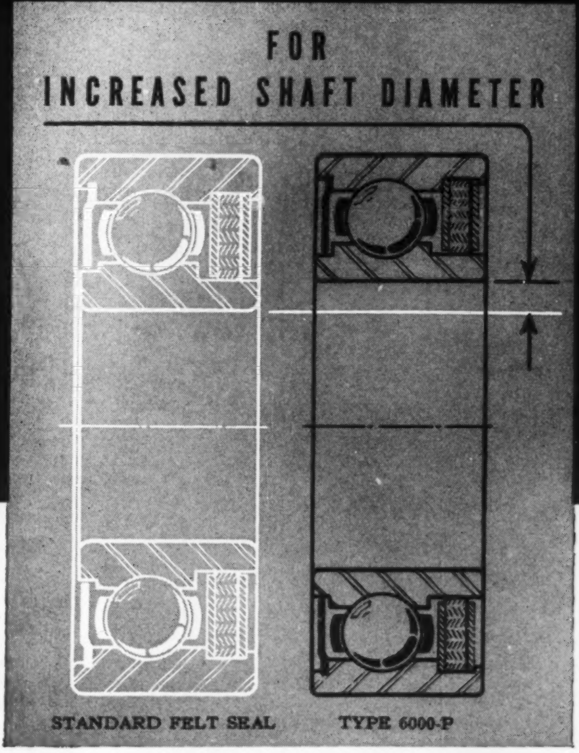
June 17-21—

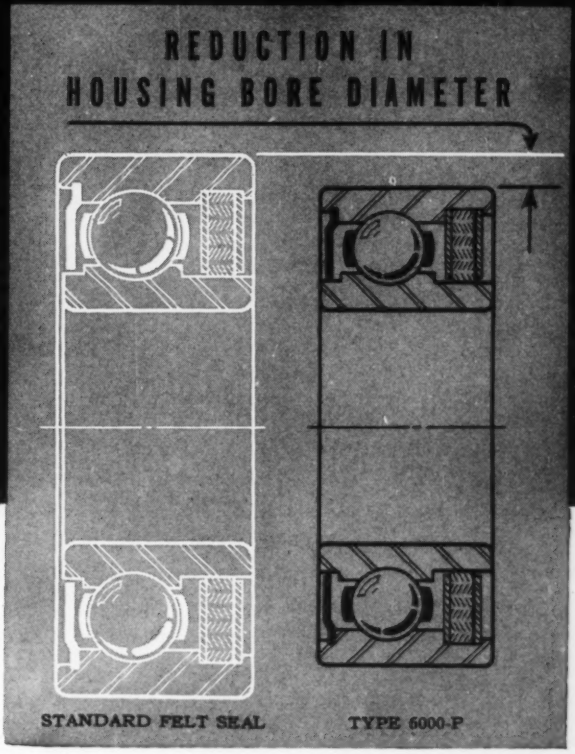
American Society of Mechanical Engineers. Semiannual meeting to be held at Hotel Pfister, Milwaukee. C. E. Davies, 29 West Thirty-ninth street, New York, is secretary.

for LIGHTER AND MORE COMPACT UNITS

use this new

EXTRA LIGHT FELT SEAL BALL BEARING





This NORMA-HOFFMANN "6000" SERIES BALL BEARING meets the needs of manufacturers of portable tools and other small high-speed units in which minimum weight is sought, center distances are restricted, and designers are cramped for space.

From the illustrations, note that the lighter proportions of the new "6000" Series permit a larger shaft in a housing of fixed diameter, or a smaller housing for a shaft of given diameter, than any standard light series felt seal bearing.

Observe also that the thick, closely-fitting, removable (Patented) felt seal is wholly within the confines of the bearing itself and therefore not exposed to injury. The wide, solid inner and outer rings make housing inserts unnecessary. Grease capacity is ample for long periods of service.

Let our engineers work with you.

BEARING NUMBER		BORE		OUTSIDE DIAMETER		WIDTH
6000 Series	6000-P Series	MM.	Inches	MM.	Inches	Inches
6010	6010-P	10	.3937	26	1.0236	.453
6012	6012-P	12	.4724	28	1.1024	.453
6013	6013-P	13	.5118	28	1.1024	.453
6015	6015-P	15	.5906	32	1.2598	.500
6016	6016-P	16	.6299	32	1.2598	.500
6017	6017-P	17	.6693	35	1.3780	.500
6020	6020-P	20	.7874	42	1.6535	.563
6025	6025-P	25	.9843	47	1.8504	.563

The "6000" series is furnished with single felt seal and the "6000-P" series with felt seal and metal shield to the dimensions shown in the table to the left; available also are "6100" (unshielded), "6100-P" (with one metal shield) and "6100-PP" (with two metal shields) series which are slightly narrower in width. Write for data sheet.

NORMA-HOFFMANN BEARINGS CORPORATION, STAMFORD, CONN., U. S. A.

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GENERAL ELECTRIC
FLAMENOL
REG. U. S. PAT. OFF.
THE NEW FLAMEPROOF OIL- AND MOISTURE-RESISTING WIRE THAT IS STRONG MECHANICALLY AND ELECTRICALLY
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12 COLORS
Black, white, yellow, red, brown, light blue, green, purple, orange, navy blue, gray, and pink
Easy to Trace Circuits

YOUR customers will take it for granted that your product is just a little bit better if it is wired with G-E Flamenol. They are becoming more aware of the fine record of the 35,000,000 feet now in service.

This is especially true if the wiring is exposed to oil Better than any other compound that we know of, Flamenol resists mild acids and oils.

But it has other advantages for the wiring of high-grade equipment—flame resistance, 12 colors, small diameter, and long life. Flamenol may thus be the answer to many a wiring problem that has long been troublesome, and our engineers will be glad to work with a manufacturer to determine whether it is the answer. Address the nearest G-E sales office, or General Electric, Dept. 6 -201, Schenectady, N. Y.

APPROVED

Flamenol oil-resisting wire is recommended and listed by the Underwriters' Laboratories, Inc., as Type FL, for use within appliances (machines) where exposed to air and to temperature not exceeding 170 F (80 C). It is also approved for other uses; see Bulletin GEA-2733C.

GENERAL ELECTRIC
INSULATED CABLE
ALWAYS RIGHT
THE RIGHT TYPE FOR EACH JOB

GENERAL ELECTRIC

520-167

ASSETS to a BOOKCASE

Diesel Engineering Handbook

Edited by L. H. Morrison; published by Diesel Publications Inc., New York; 922 *pages,* 6 *by* 9 *inches, cloth bound; available through* Machine Design *for* $6.00 *postpaid.*

The fact that constant development of lighter diesel engines is bringing them into wider fields of application makes this a valuable book for designers whose machines may now or later use this source of power. This volume is a revision of the first edition which appeared in 1936.

Virtually all matters pertaining to diesels are covered by the book, which is not a handbook in the usual sense. In development of its subject it resembles a textbook, rather than a handbook, in that lengthy discussion has been substituted for pages of tabular matter.

Accessory parts for use with diesels, such as clutches, couplings, voltage regulators, and bearings are discussed fully in separate chapters.

☐ ☐ ☐

American Machinists' Handbook

By Fred H. Colvin and Frank A. Stanley; published by the McGraw-Hill Book Co. Inc., New York; 1328 *pages,* 4 *by* 6¾ *inches, cloth bound; available through* Machine Design *for* $4.00 *postpaid.*

The seventh edition of this familiar handbook has been revised and enlarged, and as always is a reference book of machine shop and engineering department data, methods and definitions. A wealth of information is presented, in handy reference fashion. Standard dimensions or practices as set up by trade associations in the fields involved are mentioned for materials and machines. Where more detailed or special information is needed, possible sources are stated. The last chapter, a dictionary of shop terms, is illustrated profusely for clarity.

☐ ☐ ☐

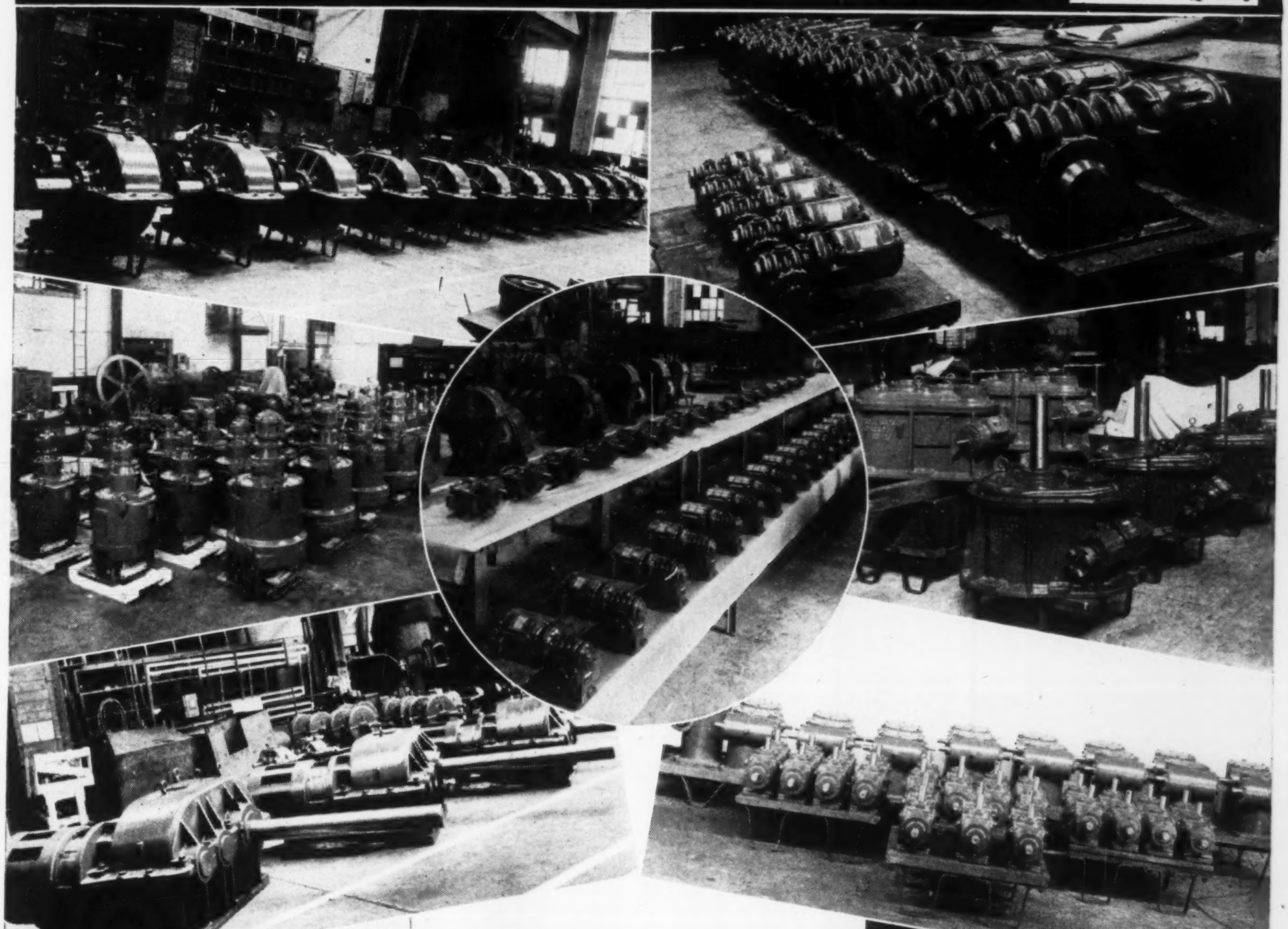
The Structure of Metals and Alloys

By William Hume-Rothery; published by the Institute of Metals, Great Britain, and distributed by the Chemical Publishing Co. Inc., New York; 117 *pages,* 5½ *by* 8½ *inches, cloth bound; available through* Machine Design *for* $1.75 *postpaid.*

This book was written with the purpose of selecting certain subjects which appear to throw light on the fundamental principles underlying alloy structures,

There is ECONOMICAL POWER DELIVERY *in These Varied and Many* IXL SPEED REDUCERS

IXL
The Mark of Quality



Ask about FIVE-POINT Deephard STEEL. It will give you increased protection against surface wear, together with greater strength and ductility — wherever you need it. Write for full details.

WHATEVER your speed reducer problem may be, we have an answer to it. IXL products are giving economical, trouble-free speed reducer service in every type of industry — and in hundreds of very special cases. There is no job too tough — no unit quantity too large, or too small for IXL. Let us hear about your requirements. Ask to see an IXL Engineer or send in your "spec's". It will pay you.

Ask for a copy of the IXL Handbook "Gear Problems". There's a wealth of information in its 660 pages — and it's free to Executives or Engineers.

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CYLINDERS

PUSH PULL RAISE LOWER

MODEL 4

Hanna Cylinders available in several models to meet mounting requirements.

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MODEL 14

Simple design and extra sturdy construction insures long life and freedom from maintenance worries.

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MODEL 4MC

Hanna Cylinders furnished with pneumatic adjustable cushions at either end or both ends.

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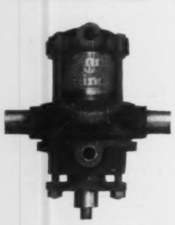
MODEL 17

Low first cost of Hanna Cylinders offers most economical method of obtaining movement in any direction.

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Push·Pull·Raise·Lower
with
HANNA
CYLINDERS
Catalogue 224

Dimensions, capacities and illustrations of all model Hanna Cylinders contained in this catalogue. Enables the designing engineer to incorporate cylinder unit into original layouts. Copy sent upon request.

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Hanna Engineering Works

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particularly those principles whose theories have undergone changes in the last 15 years as a result of increased research on electrons and the atomic structure.

Perhaps a better idea of the contents may be gained from a summary of chapter titles: The Electronic Background to Metallurgy; The Crystal Structure of the Elements; The Atomic Radii of the Elements; Primary Metallic Solid Solutions; Intermediate Phases in Alloy Systems; Imperfections in Crystals and Deviations from the Ideal Lattice.

The book is highly technical, but for designers wishing information on atomic structures of alloys, it will be found interesting and useful.

□ □ □

Modern Steels

Edited by Ernest E. Thum; published by the American Society for Metals, Cleveland; 359 *pages,* 6 *by* 9 *inches, cloth bound; available through* Machine Design *for* $3.50 *postpaid.*

A series of lectures organized by the Pittsburgh chapter, ASM, have been reprinted in this volume, and cover the manufacture, inspection, treatment and use of modern steels, including plain steels, stainless, other alloy steels, and tool steels. The authors of the various chapters are all metallurgists in constant contact with the steels they discuss. After each chapter the editor has appended notes for supplementary reading, making the book especially valuable to students. Designers wishing further information on particular kinds of steels will find the information helpful also.

Another feature is the series of exercises after each chapter, which again are primarily for beginners in metallurgy. These questions have been written in a sprightly style to make them less staid than usual.

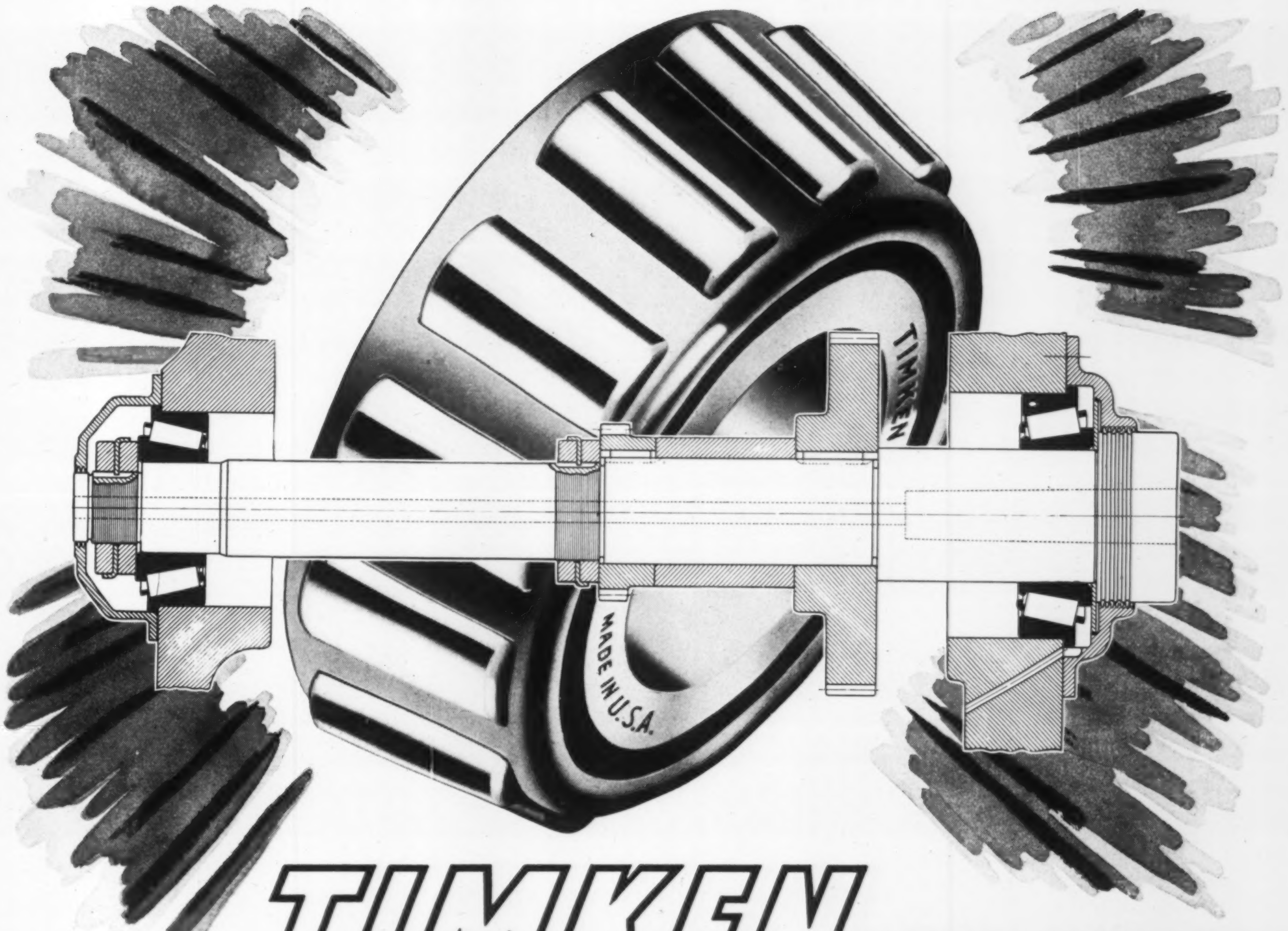
□ □ □

Heating, Ventilating, Air Conditioning Guide for 1940

Published by the American Society of Heating and Ventilating Engineers, New York; 1184 *pages,* 6 *by* 9 *inches, cloth bound; available through* Machine Design *for* $5.00 *postpaid.*

Although chiefly prepared as an authoritative reference manual for engineers in the heating and ventilating industries, the eighteenth edition of this manual contains a great amount of valuable information for designers whose fields may touch or overlap the specific ones mentioned. It supplies engineering data and information on modern equipment for application in these industries.

The new volume is less bulky and lighter in weight than previous editions because of condensation and consolidation of text matter, although one new chap-



TIMKEN BEARINGS WON'T "RUN OUT" ON YOU!...

MILES of SMILES
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BEARINGS

Run-out is the degree of irregularity in machine tool spindle rotation. It has its origin in the bearings upon which the spindle is mounted and depends upon (1) the initial accuracy of the bearings, (2) the extent of subsequent wear.

With spindles mounted on TIMKEN Tapered Roller Bearings, run-out is a negligible factor due to the exacting precision with which the bearings are manufactured and their freedom from wear even after long and severe service.

So no matter how close the tolerances may be, how high the speeds or how heavy the loads, TIMKEN Bearings won't run out on you! Make sure you have them in your new machines.

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Manufacturers of TIMKEN Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; TIMKEN Alloy Steels and Carbon and Alloy Seamless Tubing; and TIMKEN Rock Bits.

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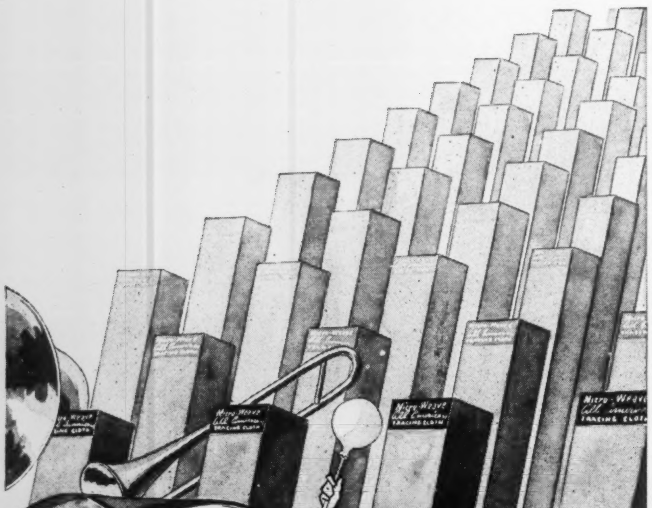

Because it was new, its very newness invited criticism — to safeguard our own interests we not only made every possible test in our own laboratories but we also invited tests in all disinterested institutions and comparative tests were made with competitive materials. Micro-Weave tracing cloth has met every challenge — strength, transparency, erasure, uniformity, aging — it is a good tracing cloth — how good it is your own use tests will demonstrate.

Write for samples — join the growing army of satisfied users.

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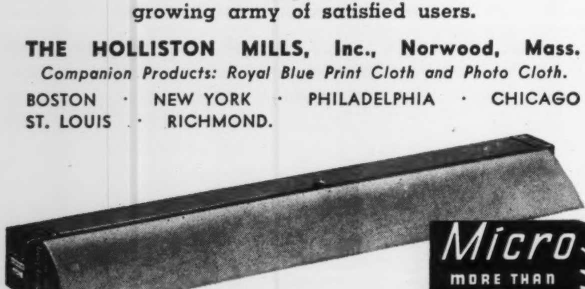

Micro-Weave
MORE THAN 180 FLAWLESS THREADS PER SQ. INCH

The dispensing roll container is a protection, a convenience and an identification. It keeps the cloth clean — handy brackets attach to desk or table.

ter has been added and others have been enlarged. A chapter index and a detailed subject index give ready reference to the technical data.

□ □ □

High Speed Diesel Engines

By P. M. Heldt; published by P. M. Heldt, Nyack, N. Y.; 475 pages, 5¼ by 8¼ inches, cloth bound; available through MACHINE DESIGN *for* $4.00 *postpaid.*

Books on diesel engines which cover specifically the high speed or automotive engine are rare, and while this type is still in a period of development, interest in it is high. European engines thus far have led the American types. The third edition of this book aims to present a condensed, orderly review of some of the research work done here and abroad on problems connected with various phases of design, with descriptive data and illustrations of typical examples of the various sub-classes that have actually been built.

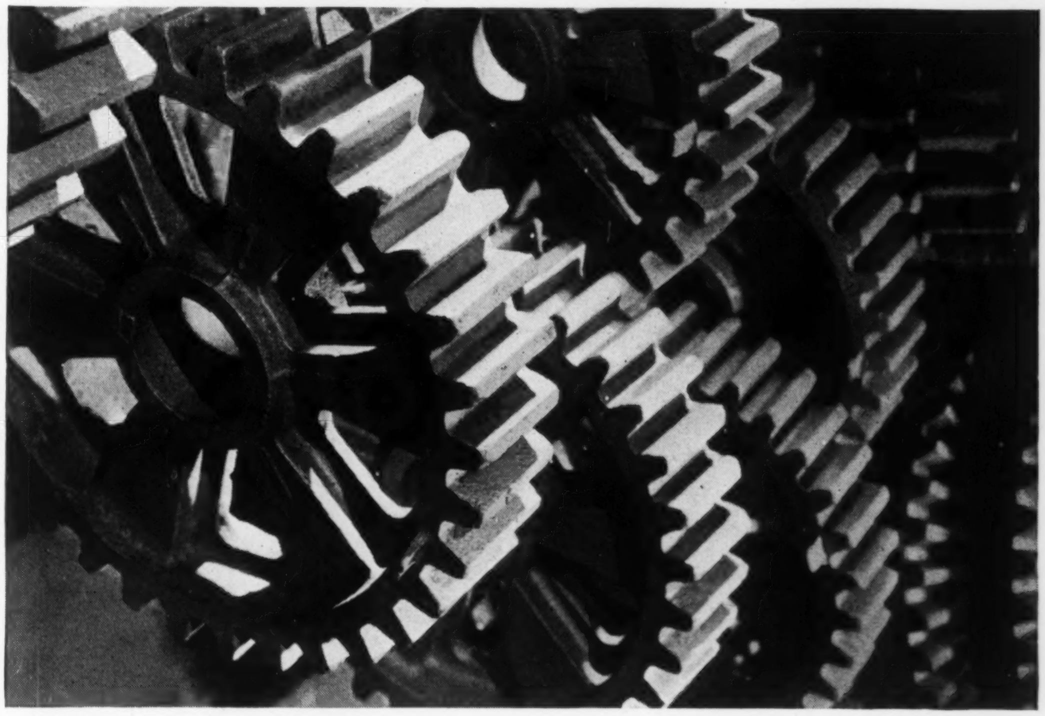
Much has appeared on this subject in periodicals, but the material is widely scattered and a good deal of it has been printed in foreign languages. This book is valuable for designers of this type of diesel engine, as well as students.

Recent Research Publications

The Effect of Range of Stress on the Torsional Fatigue Strength of Steel, by James O. Smith. Many investigators have shown that the maximum compressive stress to which a steel member may be repeatedly subjected without causing fracture depends upon the range of stress applied, that is, upon the values of the maximum and minimum stresses of a repeated cycle. Since very little information is available on varying ranges of torsional shearing stress, this investigation was to determine the effect of range of stress upon the torsional shearing endurance limit of S.A.E. 3140 steel for specimens free from stress concentrations and also for specimens containing stress concentrations caused by a transverse hole drilled through the specimen. The steel was tested in the hot rolled condition and also in a heat treated condition. It was found that for ranges of torsional shearing stress other than completely reversed cycles of stress, endurance limits for various ranges of stress have little significance if their values exceed the static elastic strength of the steel. Heat treated steels were found particularly desirable for ranges of stress other than completely reversed cycle of stress, because heat treatment raises the static strength properties. Published by the Engineering Experiment station, University of Illinois, Urbana, Ill.

CAST STEEL GEARS

are Strong · Quiet · Rigid Economical · Wear Well



All industry knows the importance of dependable gears — the parts of any machine that make it work.

Cast steel gears start with solid, homogeneous and uniform metal, with no flow lines concentric with rim to cause tooth breakage. Machining of blank gears is quick, easy and accurate, and differential hardening of parts presents no problem. Gears with cast teeth eliminate much costly machining.

And as is true of all properly designed steel castings, there is strength without excess weight, less waste stock for machining. A wide variety of mechanical properties is available.

Whatever you build, steel castings can bring you all of these money-saving advantages, plus a better, more dependable finished product. Discuss the subject with your own foundry, who will gladly work with you on these improvements. Or, if you prefer, there is no obligation involved in writing for information to Steel Founders' Society of America, 920 Midland Bldg., Cleveland, O.

IMPROVE YOUR PRODUCT WITH

STEEL CASTINGS

This Oil Seal
PATENTED
does the job Right!

You can be sure of dependable, lasting oil seal service if you standardize on the Garlock KLOZURE. The KLOZURE Oil Seal is dense, grainless, non-porous and non-abrasive. It resists water and oil at high or low temperatures; does not become soft and flabby in service. Write for catalog.

SPLIT-KLOZURE

To meet the need for an Oil Seal that can be installed around the shaft rather than over the end of the shaft, Garlock has developed the new patented SPLIT-KLOZURE. For all shafts of 3″ diameter and larger. Write for special catalog.

THE GARLOCK
PACKING CO.
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Garlock KLOZURE

Photoelastic Analysis in Commercial Practice

(*Continued from Page* 35)

amplitude and the light grows, until the retardation is exactly one half a wave length, when the vectors add directly giving the maximum possible light. Further increase now causes a darkening until, when the retardation is exactly one wave length, the original conditions are reproduced giving again total darkness. Whenever the retardation is an integral wave length, light is extingushed and whenever a half wave length, it is at its maximum intensity.

A beam of parallel rays will produce light or dark upon a screen according to the phase relation of the ray components at any particular point. The result is a pattern of light and dark bands. Each dark band, or *fringe,* is at an integral multiple of a wave length retardation and indicates a definite step in the principal stress difference. Putting it another way, a fringe connects points having the same stress difference just as a contour line in a topographical map connects all of the points together which are of the same elevation.

Bands also from Axis Inclination

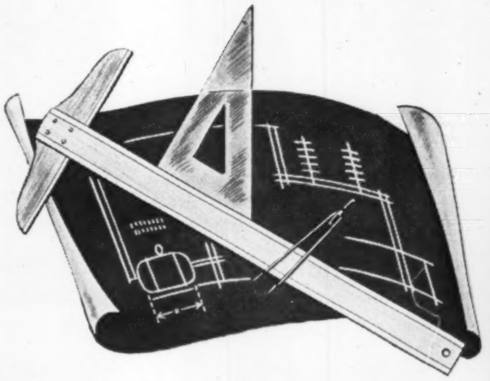
There is a variation in light intensity from another cause. The components of a ray at the center of a bright band are in phase and therefore add directly, the resultant amplitude being

$$a_r = a \sin 2\omega \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

as may be seen from *Fig.* 9. That is, the light intensity will depend upon the inclination of the principal directions. If ω is 45 degrees, the light will be at its maximum intensity; if it is zero or 90 degrees, it will be completely extinguished, the light band becoming dark. Therefore, at every point where the principal directions are vertical and horizontal there will be darkness regardless of the phase relation of the components. This gives a second system of dark bands connecting points having vertical and horizontal stress directions. These bands will move with rotation of the polarizer and analyzer to correspond to the new inclination of the polarizing axis. Because they connect points having the same inclination of the principal directions these bands have been termed *isoclinics.*

It is also of interest to examine the above phenomena when white light replaces the monochromatic beam. With zero stress difference there is no retardation and the model is totally dark, as before. As loading is increased the model will lighten to a fair amount of nearly white light. At a retardation of 3900 *A.U.* the color of that wave length (deep violet)

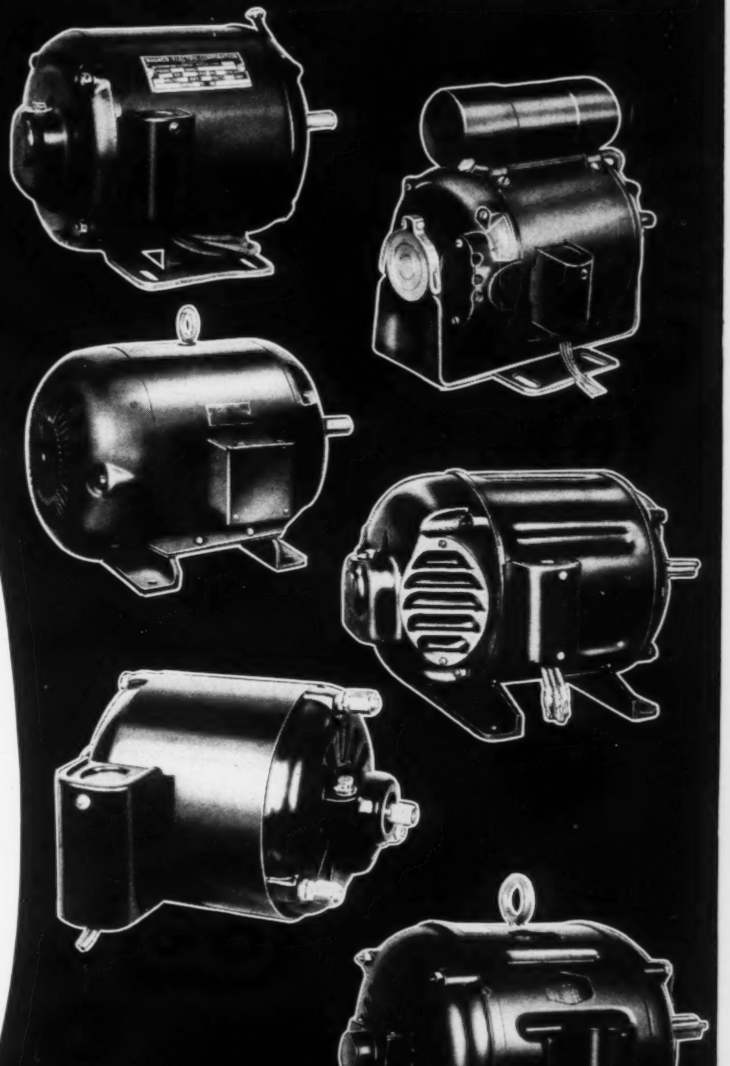
Be RIGHT Every Time! —choose WAGNER MOTORS



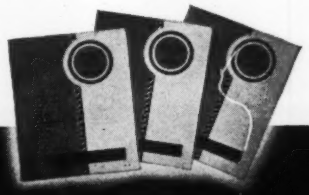
The modern trend is toward neater, more compact machinery. Sometimes the motor presents a problem in the streamlining of machinery, but not where Wagner motors are used, for Wagner motors are designed to harmonize with the most modern machinery and appliances. No longer must the motor be an unsightly appendage on an otherwise modern piece of equipment. Wagner motors are designed for compactness and neat appearance. They seemingly become an integral part of the equipment which they operate.

Appearance is only one reason why more and more manufacturers are selecting Wagner motors for their modernized equipment. There are other reasons too. Wagner motors are sturdy and reliable. Their record for performance and dependability is your assurance that they will give the kind of service you want your equipment to give. Wagner motors are so diversified in types and ratings that you can select the motor that exactly meets the electrical and mechanical requirements of each particular machine.

Wagner maintains twenty-five sales and service branches located throughout the United States. Each branch carries a stock of motors ready for immediate shipment.



Modern design...reliable performance... diversified types ...convenient location...four important considerations in the selection of motors for your equipment.



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Wherever industry's motors and engines hum, mighty presses rumble or motorized transportation speeds . . . McGILL Bearings are on the job constantly. McGILL Bearings have proven their worth in all types of uses, by manufacturers throughout the country.

Under all conditions of service . . . light-duty, heavy-duty, steady or intermittent shock loads . . . McGILL is there because there's a McGILL Bearing for practically every known bearing use. In addition, our engineering department is at the service of manufacturers who are designing new equipment requiring special custom-built bearings.

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will be extinguished, leaving the remaining wave lengths of the white light beam. This gives what is known as the complementary color of violet, a white light tinged with orange. Increase in the retardation strengthens the orange and then deepens the whole into a brick red. Then appears deep blue and then green up to 7700 *A.U.,* the upper limit of the spectrum, where white light is almost, but not quite, restored. This completes what is known as the *first order of colors.* Continued increase gives the *second order,* practically the same as the first but of a slightly different tint. This change of tint is due to overlap of the first extinction of the long waves with the second of the short; and to a difference in the velocity effect with different wave lengths. While red appears again it is now toned into a deep pink, the green predominates in the long end of the spectrum. After this successively white, pink and green occur, the pinks and greens getting paler until it is white light and darkness. These colored bands have given the name *isochromats* to the fringes.

Monochromatic Light Is Better

White light gives a more spectacular picture than monochromatic, but it is necessary to work with a particular color instead of a dark fringe. The variations in the color with the order makes this difficult and the large number of bands is apt to produce an indistinct pattern, especially at points of stress concentration. Lenses should also be corrected for color to eliminate dispersion, greatly increasing their price. For these reasons the extra expense of a monochromatic light source will be repaid many times over.

With monochromatic light source, isoclinic pattern may be removed with circularly polarized light, secured as previously mentioned by placing a quarter wave plate after the polarizing disk. The effect is as if the polarizing axis were rotated. The isoclinics, being dependent on the polarizing angle, will rotate likewise. The speed being that of the frequency of light, they disappear like the spokes of a rotating wheel. A second quarter wave plate, placed after the model with its axes reversed to the first, will retard the ray component advanced by the first. The result is to restore the original beam of plane polarized light, except as it has been affected by the model, with the isoclinics eliminated.

To sum up, the simple polariscope now consists of a light source supplying a beam of monochromatic parallel rays, a plane polarizing disk, a quarter wave plate with axes at 45 degrees, a model mounted in a suitable straining frame, a second quarter wave plate with axes reversed to the first, an analyzing disk with axis at right angles to the polarizer, a projecting lens, and a screen.

This discussion of theory and practical applications will be continued in subsequent issues.

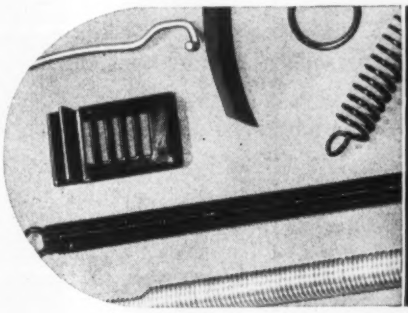
IF YOU USE Springs

. . . DON'T LET PROGRESS PASS YOU BY!

THE best steel springs you could buy last year may be only second best today. Spring designs, as well as developments in steel, change rapidly. A careful check of the springs you are using may result in greatly improving the efficiency and increasing the saleability of your product.

We suggest that you take advantage of the wide range of experience and expert assistance our engineers, designers and metallurgists have to offer. These men are daily working out problems involving springs of the most unique and complex design. The valuable assistance which these men have given is one important reason why you will find American Quality Springs serving faithfully in all of the country's largest industries.

Bring your spring problem to us. Let us design the spring that best suits your product, and supply you with American Quality Springs that will give lasting service and economy.



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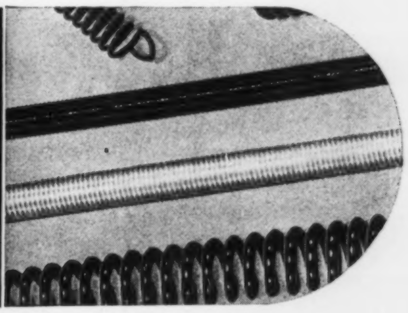

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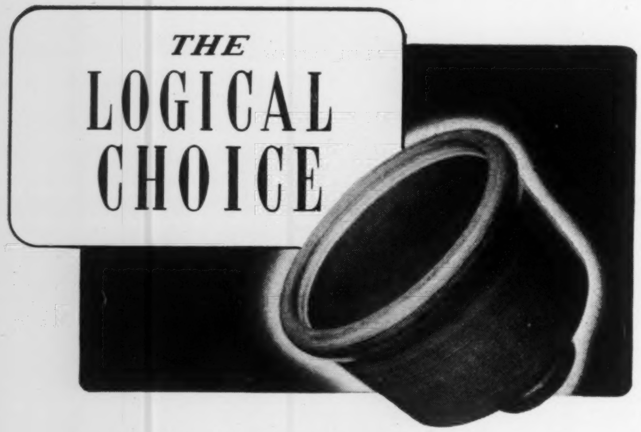

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Textolite molded-laminated is the logical choice for spinning buckets for the rayon industry because no other material provides the high specific strength and resistance to acid attack to such a necessary degree.

But the rayon industry is only one of numerous fields for General Electric's applicable material. In the refrigerator industry it has its place in the manufacture of inner doors; for business machines it is used for large housings; for game boards it provides a tough material with a highly lustrous finish.

And so on down the line—chair seats for furniture, rear decks for automobiles, electrical control boxes, enclosures for self-contained air conditioning units, stabilizers for airplanes.

The list goes on and you, too, well may be served by Textolite molded-laminated. For further information, write Section I-30, Plastics Department, General Electric Company, One Plastics Avenue, Pittsfield, Mass.

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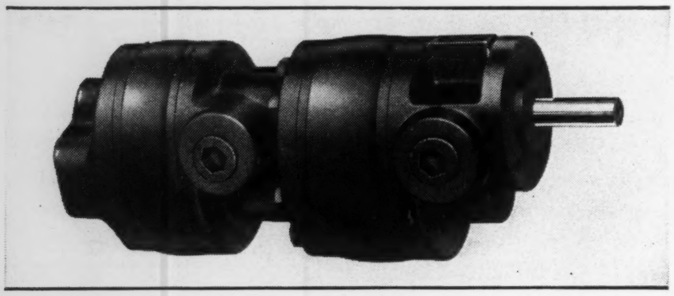

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U. S. A.

BROWN & SHARPE PUMPS

B·S

Single Instrument for Flight

(*Continued from Page* 42)

toward the bottom of the face, stalling conditions are approached. A black mark on the lower portion of the face can be added as a check point or warning mark.

For marker information, either for route flying or instrument landing procedure, two marker lights are provided which are mounted above and to the left and the right of the cathode ray tube screen. Being mounted so close to the center of interest, they are readily visible without distracting from the attention which must necessarily be devoted to the center of the screen. A ball bank indicator is placed just below the cathode ray tube screen. The ball bank indicator is necessary as it is only by its use that the proper degree of bank may be maintained for any given rate of turn. This instrument is so simple that it has never been considered worthwhile to show its indication by means of a cathode ray tube luminous line.

Electrons Draw Patterns

Desired patterns are drawn on the screen by electrostatic deflection of a pencil beam of electrons with the tube. Wherever this pencil of electrons strikes the screen, the fluorescent material of which the screen is composed becomes luminous. In order to produce a line or a circle, an alternating voltage is applied to either vertical or horizontal deflection plates in the correct phase relationship to cause the spot to trace out the desired figure. Each instrument has attached to it a signal pick-up so constructed that no appreciable power is taken from the instrument. When this pick-up is centrally located relative to two stationary elements, no deflection voltage is applied to the cathode ray tube beam. However, if the instrument deviates from the normally set-in position, a differential alternating voltage is produced which, when rectified and amplified, is applied to deflect the desired pattern on the face of the cathode ray tube. Since there are four separate indications on the face of the Flightray, switching is necessary. To accomplish this, the various amplifiers associated with each instrument pick-up are sequentially made operative by means of a commutator which applies suitable control voltages to each amplifier in turn.

Permits Remote Location

Simple electro magnetic pick-up, which permits remote location of instruments, is an application of the miniature Telegon alternating current selsyn. When used for supplying deflection voltages for patterns, only the transmitter element is employed. A balanced diode rectifier delivers the necessary direct current

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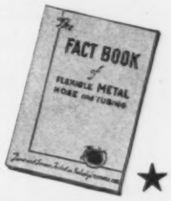
AND TUBING are strong . . . safe . . . long wearing . . . non-disintegrating . . . insoluble . . . resistant to heat . . . mechanically and physically stable . . . designed to flex without fatigue . . . able to absorb vibration . . . positive protection against static electricity . . . far less costly in the long run . . . the correct specification for an exceptionally wide range of applications requiring a flexible connection.



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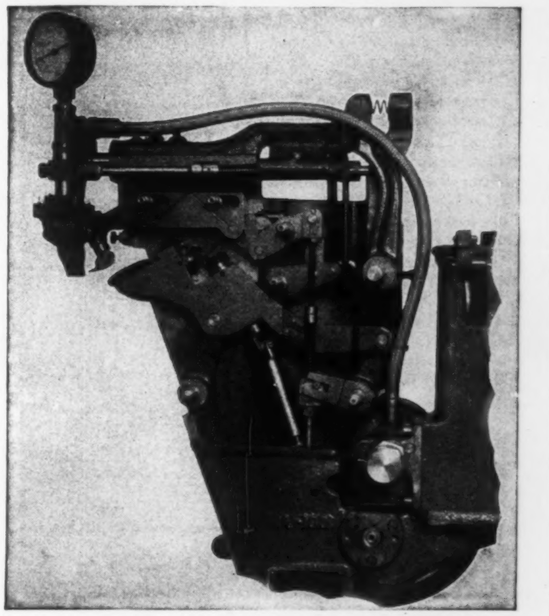

1940 COBBLER'S TOOL...

This modern shoe-making machine is fed special shoe cement through the length of Flexible METAL Tubing shown in this picture...a good example of the way clever design engineers now solve flexible connection problems on production machinery.

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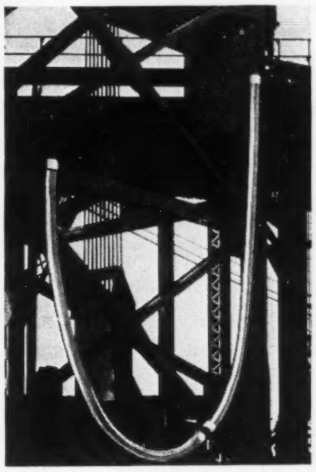
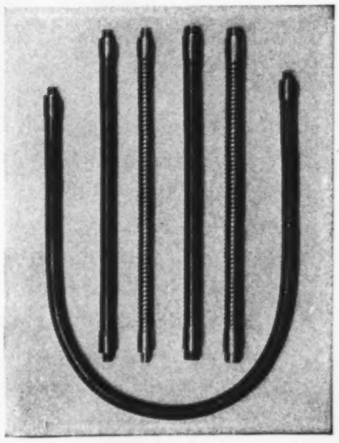


VITAL BRIDGE LINK

One of two 60 ft. lengths of 8" Flexible METAL, rubber covered, heavy duty hose to convey city gas, installed at ends of drawbridge to insure continuous flow of city gas regardless of position of bridge.



STAYS PUT . . .

That's the main purpose in life of Flexible METAL arm units such as these, whether they're part of a desk lamp assembly or conveying cutting oils to the business end of a high speed automatic lathe.

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Gasoline pump hose serves millions daily, handles a tough job well. For 25 years Flexible METAL Hose Lining has been standard for long service plus safety. Perhaps the same principle can save maintenance and money in your business.

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M-2

Name.. *Title*..................

Address..

to the commutated vertical or horizontal amplifiers. The Telegon, being small, light and exhibiting negligible coercive force, is readily applied to existing flight instruments. Because the device operates at low audio frequencies, placement of signal instruments is unrestricted by lead length and these instruments can therefore be located anywhere they may be desired on the aircraft.

Freedom of apparatus location permits the signal instruments to be mounted on the flight panel, where they serve to prevent duplication of flight instrument equipment on board the aircraft. Being entirely unaffected by the addition of the pick-up device they then become the stand-by instruments. The instruments are provided with setting dials—thus allowing the entire flight picture to be set up on the instrument panel just as is done when the automatic pilot is employed.

No Flicker Is Visible

Cathode ray power supply is unusual in that a high impedance source of direct current at 2000 volts is required. This voltage is obtained from a small dynamotor running from the aircraft's normal battery system. The dynamotor does not supply the high voltage directly but supplies an alternating current which is then transformed and rectified for the operation of the cathode ray tube. The same machine also supplies direct current for the amplifiers. Total power requirements are less than 100 watts for the entire system.

Patterns are placed on the screen in sequence and at a rate well above the threshold of visible flicker. But since this threshold increases in frequency with increased pattern brilliance commutation rates of less than 30 cycles are objectionable. In order to be entirely safe a frequency of nearly 60 cycles is desirable. Frequencies this high, however, impose many design specifications which are especially severe, due to the high order of reliability which must be maintained.

One of the most promising types of commutators has been electronic which is satisfactory except for high power requirements and circuit complexity. Lately, however, a new type of mechanical switch, providing both commutation and return trace blanking voltages, has been adopted. This device is simple and on life tests has proven to be thoroughly reliable. Although work on other types of commutators has not ceased, it is felt that this newer development will serve for some time to come.

At first it was thought that pilots would object to luminous lines. Many pilots, however, have flown with the instrument and have found the soft fluorescent pattern suitable either by day or by night. Development of this subject is still incomplete although considerable work and testing have already been accomplished.

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SPEED REDUCERS
ABART GEAR & MACHINE CO.

Abart Type "AD"—Worm Gear Reducer—Vertical Type for fastening to top, bottom or end of tank, kettles, etc. Ratios 4-5/6 to 1 up to 100 to 1. 1/2 hp. to 98 hp.

If you have anything to do with power transmission—and speed reduction problems in particular, we believe you will like to have the Abart Speed Reducer Catalog. In it you will find complete specifications and list prices of a full line of reducers, a complete range of horsepowers and ratios to meet practically all requirements. Many sizes are carried in stock ready for immediate delivery. Write for this catalog.

ABART GEARS. No stocks, made to specifications, and to meet your requirements. Quick delivery.

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Where cleanliness is a factor—where bearings must be located in inaccessible places—where dependable service without constant inspection and maintenance are desirable, specify

RHOADES METALINE
Oilless Bronze Bearings

Send for our new and complete catalogue, which contains data on design, specifications and application. Our engineers will cooperate with you in solving bearing problems.

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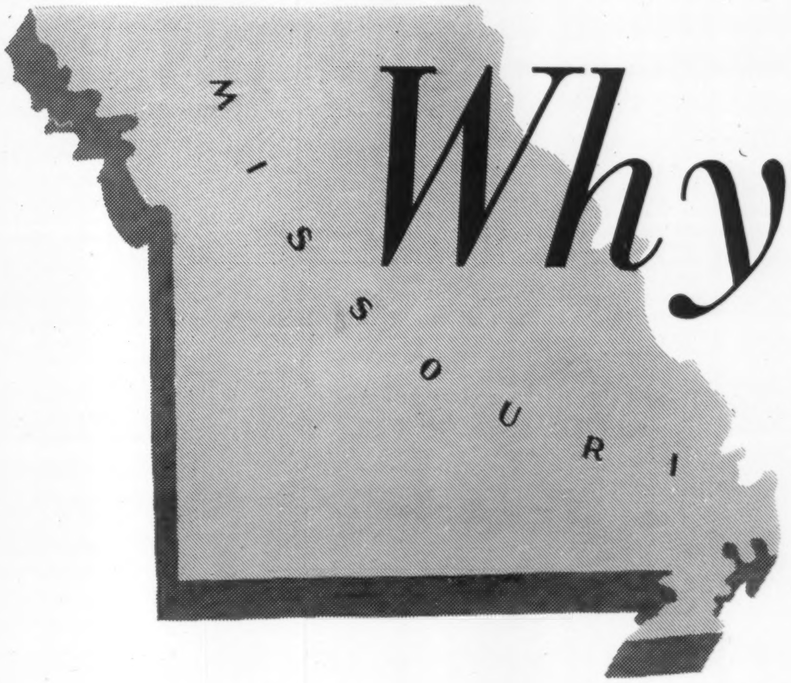

Why . . .

. . . . are all good design engineers "from Missouri?"

Simply because the "I'm from Missouri" attitude is basic to successful engineering design . . . parts, materials, methods and finishes may work perfectly in one application but if applied somewhere else they may fail. Design engineers must KNOW how they will function in the machines they are developing . . . they cannot afford to take any chances.

MACHINE DESIGN encourages this attitude by constantly placing before its readers solutions to every type of design problem. Our editors are in touch with hundreds of designers and examine scores of manuscripts monthly ferreting out pertinent information which must meet an exacting editorial formula.

To get every article in its best form for our 32,000 design engineers and executive readership requires all the thought we can command.

Also necessary is careful planning. Maintenance of balance is essential in editorial structure of MACHINE DESIGN in order that the complete field of parts, materials, methods and finishes as they apply to design of machinery may be thoroughly covered. That's why our editors are always looking months into the future . . . why they instantly are alert to new applications of parts, new processes and materials.

Recognizing the results of long-range planning on the part of our editors, who are themselves engineers, readers find every issue of MACHINE DESIGN the one medium whose editorial content, distribution and readership are concerned alone with the design and redesign of machinery.

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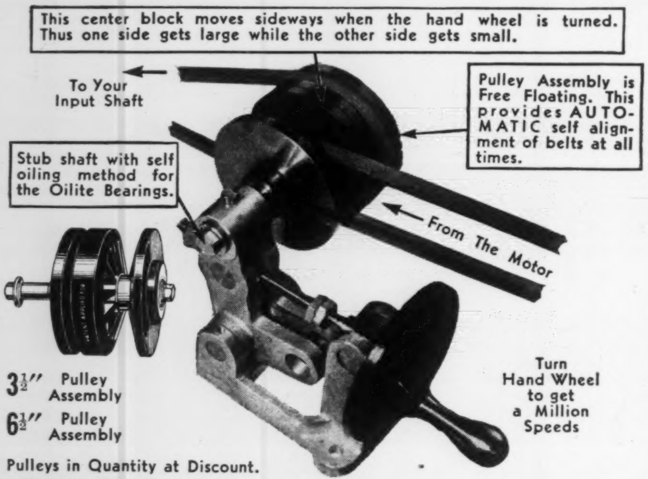
This center block moves sideways when the hand wheel is turned. Thus one side gets large while the other side gets small.
To Your Input Shaft
Pulley Assembly is Free Floating. This provides AUTOMATIC self alignment of belts at all times.
Stub shaft with self oiling method for the Oilite Bearings.
From The Motor
Turn Hand Wheel to get a Million Speeds
3½" Pulley Assembly
6½" Pulley Assembly

Pulleys in Quantity at Discount.
Mounting Brackets to Order.

Not Just 3 to 1 . . . . BUT OVER 6-to-1 RATIO
No Special Belts . . . . JUST STANDARD "V" BELTS
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No Shifting of Motor . . . . MOTOR STAYS PUT
No Metallic "Sing" . . . . . NOISELESS WITH MOLDED PLASTIC
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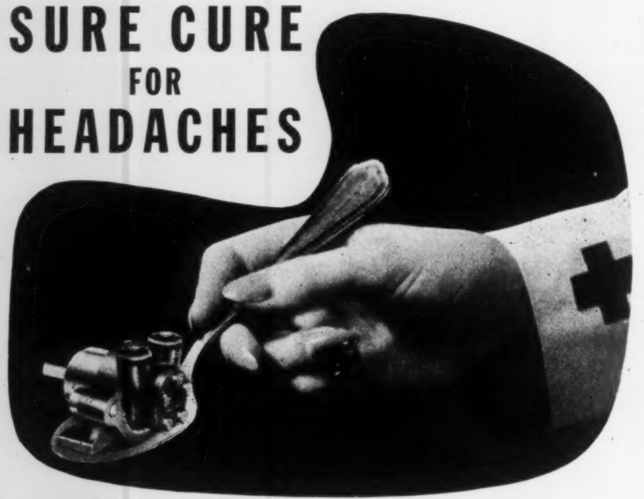

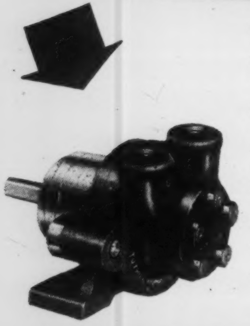

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MANUFACTURERS' *publications*

ALLOYS (NICKEL-CHROMIUM) — Catalog R-40, published by Driver-Harris Co., Harrison, N. J., contains complete engineering information on Nichrome alloys in various shapes. These alloys are heat and corrosion resisting for electrical applications. Curves and tables are plentiful.

BEARINGS—Koppers Co., Bartlett Hayward division, Baltimore, Md., has issued a booklet describing its new Fast's multiple oil film bearings designed by Gustave Fast. The booklet outlines the history of bearings, discusses the principle of Fast's bearings, describes and illustrates their design, provides tables of dimensions and load capacities.

BEARINGS (BRONZE)—Bound Brook Oil-less Bearing Co., Bound Brook, N. J., has issued a bulletin discussing its graphited bronze bearings, made of cast phosphor bronze inlaid with hard graphite. Applications and typical uses are listed. Other information stresses dimensions, tolerances, and permissible loads.

BEARINGS (BRONZE)—General catalog No. 40, just issued by Bunting Brass & Bronze Co., Toledo, O., describes many new sizes of standardized bronze bearings, and includes a complete listing of precision bronze tubular and solid bars, babbitt metals, and special products and services. The section devoted to electric motor bearings also mentions new parts.

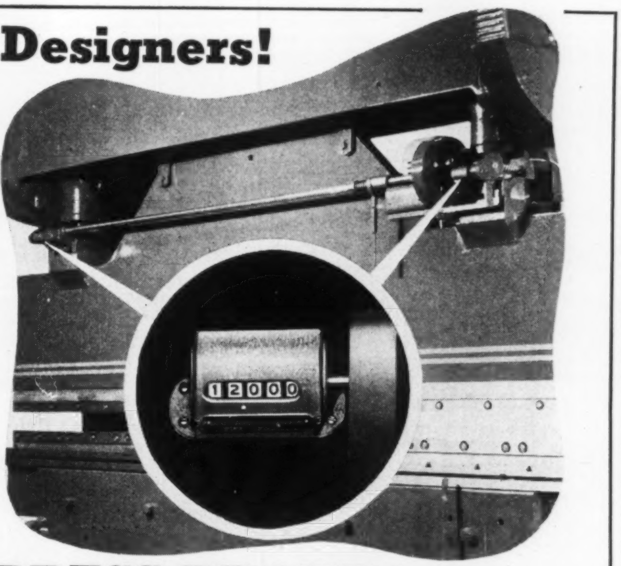
BEARINGS (TAPERED ROLLER)—Supplement No. 2 has been added by the Bower Roller Bearing Co., Detroit, to its Engineering Journal. It includes dimension sheets for a number of new tapered roller bearing series.

CHAINS—An informative four-page folder, No. 1804, has been issued by Link-Belt Co., Indianapolis, describing its bronze drive and conveyor chains for resisting the destructive effect of organic and inorganic acids.

CHAINS—Complete information on applications, capacities and construction of Morse roller chain is contained in a new bulletin, R-54, issued by the Morse Chain Co., Ithaca, N. Y. A partial list of contents includes power transmission capacity tables for pitches from ⅜ to 2½ inches, a guide for calculation of chain lengths, and tables showing sprocket dimensions and types.

CHAINS (ROLLER)—An improved type of roller chain with provision for internal lubrication is described and illustrated in a new booklet issued by The Howe Mfg. Co., 7500 Euclid avenue, Cleveland. A film of oil is constantly maintained between the bushing and roller and between the bushing and pin by a felt wick which is placed between the two segmental bushings,

Designers!



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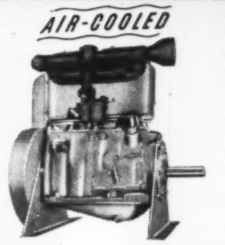

Modern, heavy-duty air-cooled power 12 Sizes - 1 to 35 H.P.

Notice the angle of operation in this WISCONSIN 4 cylinder air-cooled engine. The positive oiling system which precludes oil pumping regardless of angle of operation, makes this installation possible.
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Specify **UNBRAKO**

SELF-LOCKING HOLLOW SET SCREWS with the Knurled Points

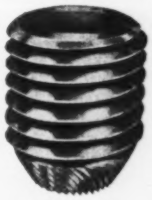

Fig. 1645
Pat's. Pend.

By equipping the machines they design with "Unbrako", many designers are insuring their products for a long life of trouble - free operation. Machinery breakdowns and high maintenance costs, caused by ordinary set screws jarring loose, can be prevented very simply from the first by using "Unbrako" Self-Lockers.

Ingenious knurling around the cup points automatically and surely locks them in place when tightened in the normal way. And no amount of vibration can loosen them. Yet these screws are easily set up, as easily removed and they may be used indefinitely with the same dependable effectiveness. Incorporate "Unbrako" in YOUR designs.

Fig. 1641
Pat's. Pend.

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the bulletin clearly pointing out features of this chain.

CLUTCHES—Over-center and spring-loaded clutches and power take-offs are discussed and illustrated in a four-page folder in color issued by Rockford Drilling Machine division, Borg-Warner Corp., 1307 Eighteenth avenue, Rockford, Ill. Features and advantages are listed clearly and typical applications for these parts are shown.

CONTROLS (ELECTRICAL)—Automatic controls featuring the Mercoid mercury switch, in many sizes and types, are fully described and illustrated in catalog No. 400 issued by The Mercoid Corp., 4201 Belmont avenue, Chicago. Wiring diagrams for parts like thermostats requiring special wiring are shown. Prices are given.

CONVERTERS—For changing direct current to alternating, rotary converters are described in a new folder, No. 13-25, issued by Janette Mfg. Co., 556 West Monroe street, Chicago. Prices and capacities are given, as well as instructions for applying and ordering.

CONVEYORS—Copiously illustrated, a 48-page book, No. 1700, has been published by Link-Belt Co., 307 North Michigan avenue, Chicago, showing many different applications of mechanical elevating and conveying equipment. It also contains several pages of statistics and thought-provoking matter on the theme that greater development and use of machines had placed America's standard of living above all others.

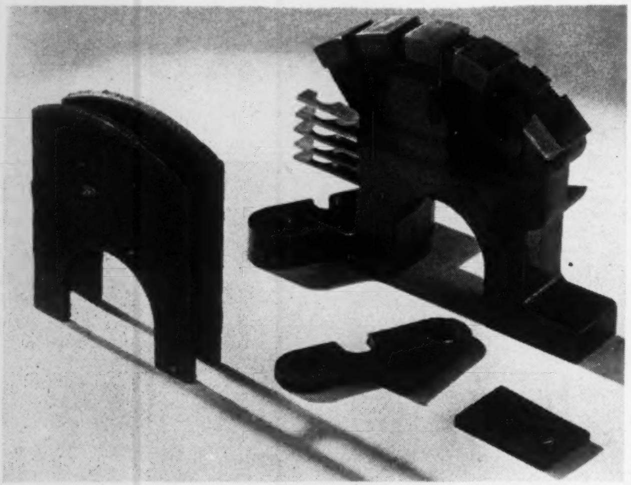
DRIVES — Link-Belt Co., Chicago, has published a pocket-sized magazine containing reprinted editorials from its house organ, "Link-Belt News." The editorials are chiefly of an inspirational character, were written by many different persons and in general, urge observance of simple virtues.

ENGINEERING AID DIRECTORY—For the first time, Allis-Chalmers Mfg. Co., Milwaukee, has issued a complete directory of engineering literature and bulletins covering the hundreds of products it makes. Prepared in the form of a handy 32-page book, the directory lists in numerical order more than 350 separate bulletins and other engineering aids now available.

FASTENINGS—An attractive, illustrated catalog discussing Elastic Stop nuts and their applications has been published by Elastic Stop Nut Corp., 1001 Newark avenue, Elizabeth, N. J. It covers the self-locking principle of these nuts in all its uses and gives dimensions on the complete line. Instructions for applying are also included.

FINISHES (RESINOUS)—Bakelite varnish, enamel, lacquer and cement, which are hardenable upon application of heat, are discussed in the third edition of a booklet published by Bakelite Corp., 247 Park avenue, New York. Properties, uses and methods of application of each material are covered thoroughly.

GEARS—A particularly interesting section in a new



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if reinforced with resin board. Resin board is a combination of fibre board containing paper rag stock which has been impregnated with phenolic resin. It is a highly shock resistant material with good insulating properties.

In the controller switch molded by us for the Automatic Transportation Company, 13 resin board blanks are used in combination with 173 grams of phenolic molding material.

These blanks provide necessary shock resistant strength, electrical insulation and act as extra support for the five heavy metal contact inserts molded in the control. Choosing the right materials is important. Our engineers will gladly assist you in solving your material and molding problems.

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1028 North Kolmar Ave. Chicago, Illinois

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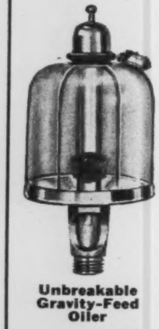
SAVE
OIL — TIME — WORRY

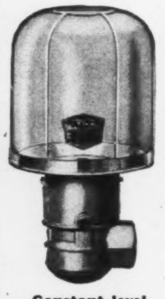


Unbreakable Gravity-Feed Oiler

Wherever improved machine performance, longer life and lower maintenance costs are important you will find TRICO OILERS installed.

- They guarantee proper lubrication of your equipment after it is in service.
- They are modernized and streamlined to harmonize with advanced ideas of machine design.
- Give you that added sales feature.
- Reduce selling resistance.
- Place you a step ahead of your competitor who still thinks the old-fashioned oil - can is good enough.

Write for your FREE copies of Bulletins Nos. 24, 25 and 26. They serve as a bible on automatic lubrication.



Constant-level and thermal GLASS Oilers

Unbreakable Constant-level Oiler

TRICO FUSE MFG. CO., Milwaukee, Wis.
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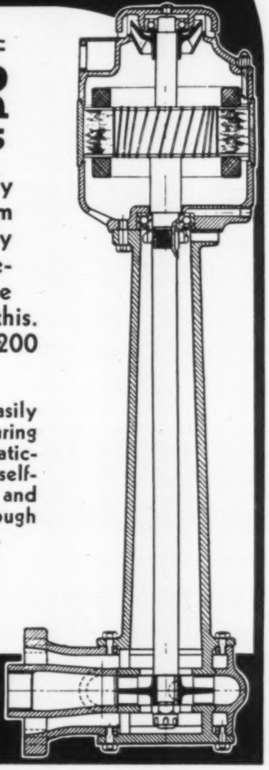
TODAY'S PUMP FOR TOMORROW'S MACHINES

RUTHMAN
GUSHER
COOLANT PUMPS



The present trend is to simplify machine tools, to make them more compact and in reality beautify them. Ruthman pipeless Gushers make it easy for the designer to do this. Models up to 200 G.P.M.

Gushers are easily mounted, ball-bearing equipped, hydrostatically balanced, self-cleaning, and grit and abrasives pass through them without harm.

Write for engineering data and specifications.

THE RUTHMAN MACHINERY CO.
540 E. FRONT ST., CINCINNATI, OHIO
LARGEST EXCLUSIVE BUILDERS OF COOLANT PUMPS

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Western Felt
at your service . . .

● Western's 41 years of experience in manufacturing and cutting felt is at your disposal. Extensive laboratory facilities insure the best possible solution to your problems. You are under no obligation whatsoever in making use of our free research services. Write today.

Just a few of the many uses of Western Felt:

Sound Deadening	Sealing Bearings
Vibration Absorption	Conveying Lubricants
Heat Insulating	Filtering Liquids

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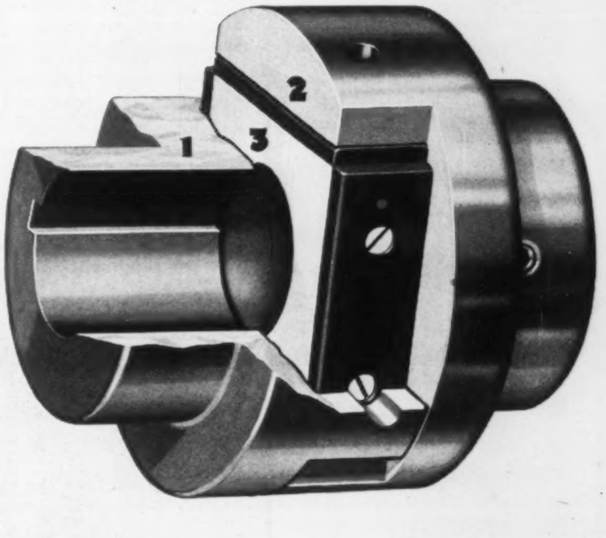
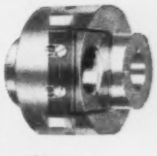
FELT WORKS
4037-4117 Ogden Avenue Chicago, Illinois
Largest Independent Manufacturers and Cutters of Wool, Hair and Jute Felts. Established 1899.
BRANCH OFFICES IN ALL PRINCIPAL CITIES

"KIND OF OBVIOUS, ISN'T IT?—LESS PARTS USUALLY MEANS LESS MAINTENANCE AND LOWER PRODUCTION COSTS."

American Flexible Couplings
HAVE ONLY 3 SIMPLE–RUGGED PARTS
2 identical jaw flanges—1 floating center block





● The purchaser of the equipment you design is after low cost performance. "Down time" boosts costs. You can reduce the "down time" occasioned by coupling maintenance to a minimum by specifying American Flexible Couplings.

These couplings are a new application of the proven Oldham Principle. The floating metallic center block being free to float in any direction compensates for both offset and angular misalignment. No binding or cramping of bearings.

Maintenance is simplified. Wear is absorbed by inexpensive and easily replaced non-metallic bearing strips on the load bearing surfaces of the floating metallic center block. More information upon request.

AMERICAN FLEXIBLE COUPLING CO.
(Trade Name Reg. U. S. Pat. Off.)
Erie, Pennsylvania

AMERICAN FLEXIBLE COUPLINGS *provide complete flexibility without flexible materials*

Blue
DEVIL
The
ARISTOCRAT
of
SOCKET SCREWS

1 — Cold-formed heads — unimpaired continuity of fibres.

2—Tensile strength 215-225,000 lbs. sq. in.

Try our service on your special sizes.

3—Precision formed hexagon socket with true sides and no taper.

4—Chamfered edge knurled to facilitate assembly.

Blue Devil Cap Screws are unbelievably tough, and are heat treated in electrically controlled furnaces. Send for catalogue and samples.

Nothing too large - Nothing too small for
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FORECAST
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HUNTER
PRETESTING!

Determine *in advance* the exact performance your springs will give! Hunter detailed analysis of designs and reports on performance help you find the best springs for your purpose; guesswork is eliminated; *facts* make buying safe! This is a FREE Hunter service—it's the No. 1 step toward spring quality and economy.

Just ask to have a representative call; there's no obligation!

PRECISION
MADE

Springs
by Hunter

HUNTER PRESSED STEEL CO., LANSDALE, PA.

booklet entitled, "For Better Gears," is a section on "Locating Gear Troubles," which contains information on gear design calculated to prevent common errors. Published by Michigan Tool Co., 7171 East McNichols road, Detroit, the booklet also contains a number of articles on factors affecting gear performance.

HEATING UNITS—New and improved electric heating units and controls, designed to meet specific industrial applications for heating liquids, solids and air, are announced in a new 38-page illustrated catalog, No. 28-000, issued by Westinghouse Electric & Mfg. Co., Mansfield, O.

LUBRICATION—Mining machinery lubrication is the subject of the latest issue of the *Lubriplate Film,* published by Fiske Bros. Refining Co., Newark, N. J. It discusses how the severe conditions of mining call for high grade lubricants in machinery.

LUBRICATION—Title of a new condensed catalog folder issued by the Trico Fuse Mfg. Co., 2948 North Fifth street, Milwaukee, is "14 Big Trouble Savers." It contains complete specifications and illustrations of automatic lubricators for all types of bearing surfaces, as well as information on Trico fuses.

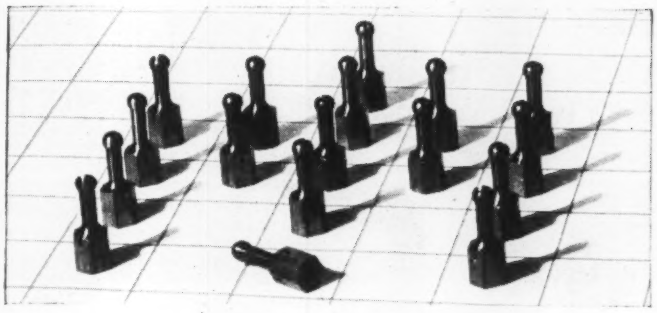
PLASTIC MOLDINGS—A section devoted to "Case Histories" in a new catalog issued by F. J. Stokes Machine Co., Tabor road, Philadelphia, presents figures to show how automatic molding machines saved money enough on single jobs, in 100 working days, to pay for the cost of the machine. Typical plastic moldings are illustrated.

PULLEYS (VARIABLE SPEED)—Stepless speed delivery is possible with the Speedmaster variable speed pulley described by Speedmaster division, Continental Machines Inc., Minneapolis, in a new folder just announced. Practical applications are illustrated and engineering service on special problems is offered.

SPRINGS—A new 36-page fully illustrated catalog has been published by Fort Pitt Spring Co., McKees Rocks, Pa. Springs described include elliptical, freight truck, equalizing, compression, coil and helical. Specifications, calculations, formulas and useful tables are included, along with a discussion of heat treatment of springs.

STEEL (STAINLESS)—"The Fabrication of U.S.S. Stainless Steels," a 92-page book bound in stiff covers, has been issued by United States Steel Corp. subsidiaries. The book is divided into three comprehensive sections, discussing in detail the technical and practical aspects of fabricating austenitic, ferritic and martensitic stainless steels. Nominally the book carries a charge of one dollar.

TAPS, DRILLS—To save time and eliminate guess work when figuring machining work, a handy tap and drill chart has been issued by the Dumore Co., Racine, Wis. It is printed on durable stock and can be tacked up in engineering departments for quick reference.



"Plugs"!

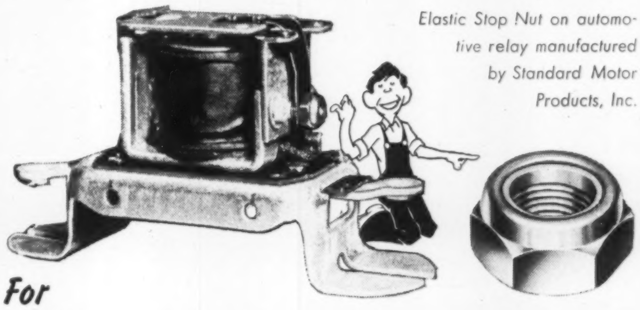
EXAMPLES of clean slotting and accurate inside drilling and tapping of phosphor bronze. Just one more item in the never-ending parade of design elements that leaves Peck screw machines for assembly throughout the U. S. and elsewhere.

If you believe that the more you do a thing, the better you can do it—then you understand the reason for this "Parade" and we hope you will join it when next in need of parts.

SEND FOR FREE HANDBOOK

of springs and screw machine parts, also special information for designers and engineers. Please write on your letter head.

PECK SPRINGS
AND SCREW MACHINE PARTS
The Peck Spring Co. 10 Wells St., Plainville, Conn.



Elastic Stop Nut on automotive relay manufactured by Standard Motor Products, Inc.

For

ACCURATE SPRING ADJUSTMENT

. . . among the many uses of Elastic Stop Nuts on electrical equipment

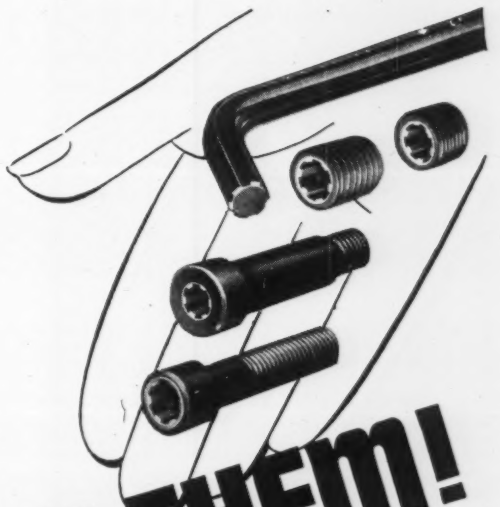
WITH Elastic Stop Nuts, precision nut or screw adjustments are maintained under any condition of vibration. Because of their resilient self-locking action, these nuts remain in position at any point on a screw, without the aid of a supporting surface.

Use them for all important fastenings . . . they are available in a wide range of types, sizes and materials.

← Write for this 56-page Catalog

ELASTIC STOP NUT CORPORATION
1011 NEWARK AVENUE • ELIZABETH, NEW JERSEY

Elastic Stop SELF-LOCKING NUTS



TRY THEM!
FREE SAMPLES
BRISTO SOCKET SCREWS

Convince yourself that Bristo's faster, easier, tighter set-up means speedier assembly, stronger construction, minimum assembly cost. All you have to do to get Bristo Socket Screws for an "on-the-job" try-out, is to mail in the handy coupon below. It brings you a tidy selection of Bristo Screws and Wrenches for you to set up—either on your products or your production machinery.

BRISTO'S THE CHOICE . . . *for good reasons!*

These easy-to-handle socket screws set up tighter, and with less effort. And they stay tight, too,—holding with a grip that defies vibrations. The exclusive fluted design of the socket head permits greater force without weakening, without danger of stripping or rounding out. Time and again a Bristo can be backed off and retightened without damage to the socket. Use of a Bristo reduces necessity of frequent replacements. Assembly time is saved. No wonder so many manufacturers have standardized on Bristos!!

QUICK BRISTO FACTS

Lock-tight socket head, won't split, shear, round out, jam or strip . . . Set tighter with less effort. . . . No loosening under vibration. Take wrench without fumbling . . . or skidding.

MAIL THIS COUPON!

Free Bristo samples, and Bulletin 83-8N which gives you facts on these labor-saving screws, are ready for you. Send for both today. The Bristol Company, Mill Supplies Division, Waterbury, Conn.

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SOCKET SCREWS

THE BRISTOL COMPANY, Mill Supplies Division
Waterbury, Conn.

Send me sample Bristo Socket Screws and Bulletin 83-8N.

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Relays AC-DC
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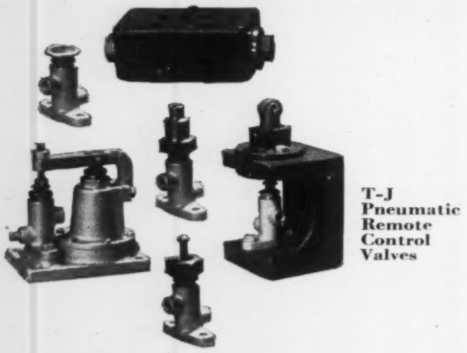


LOWER-COST AUTOMATIC MACHINE CONTROLS of WIDER RANGE

Pneumatically controlled operating cycles provide manual operation versatility plus automatic operation speed. Those problem processes that you have been unable to remove from the pain-in-the-neck class can very probably be smoothly yet swiftly effected by T-J Pneumatic Controls. Send description of required cycle of operations and time of operations. We will gladly make recommendations. Bulletin RC-4 will show you typical applications and standard units.

this is a **TOMKINS-JOHNSON** *product*

Write to The Tomkins-Johnson Co., 618 N. Mechanic St., Jackson, Michigan Agents in principal cities.

Business and Sales Briefs

PATENTS, machinery and assets of Dayton Mfg. Co., Torrington, Conn., manufacturer of counting devices, meters and registering equipment, have been acquired by Veeder-Root Inc., Hartford, Conn. The Torrington concern will be moved to Hartford.

*

To cover the Buffalo area, including the western portions of the states of New York and Pennsylvania, for Tennessee Eastman Corp., David C. Williams has opened an office at 1508 Rand building, Buffalo. Teletype service to the home office of the company at Kingsport, Tenn., will be maintained.

*

Formerly vice president in charge of sales of Emerson Electric Mfg. Co., St. Louis, Oscar C. Schmitt has been elected executive vice president. Raymond E. Otto, previously manager of motors sales, has been named manager of sales, and William R. Fraser becomes manager of motor sales, with O. D. Metz as his assistant.

*

Since 1926 identified with the sales department of the industrial division of The Timken Roller Bearing Co., M. H. Kuhl has been made assistant manager of the division succeeding S. D. Partridge who recently became manager of the division.

*

Inland Steel Co., Chicago, has named Benton J. Willner and Maurice E. O'Brien as assistant vice presidents. Mr. Willner will assume the position as manager of sales, sheet and strip steel division, of which he has been assistant manager of sales since 1936. Mr. O'Brien is manager of sales, carbon steel bars and billets.

*

Starting with the American Steel & Wire Co. in 1912, Walter E. Mackley succeeds F. O. Howard as manager of the Buffalo office of the company. Mr. Howard has been transferred to New York.

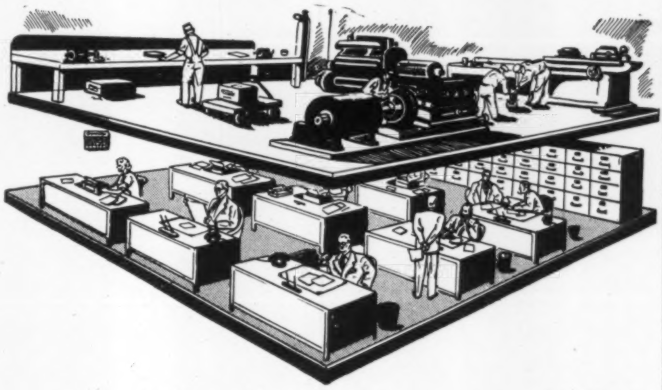
*

Larry N. Succop will represent American Roller Bearing Co., Pittsburgh, as sales engineer in the southwest. Mr. Succop, son of the president of the company, C. F. Succop, completed his engineering education at Carnegie Institute of Technology, and spent a year in the engineering department of the company before taking up his field duties. His headquarters will be at Houston, Tex.

*

Among appointments by the Chain Belt Co., Milwaukee, is that of L. B. McKnight, formerly sales manager

Overhead Noise HERE



means Overhead Expense HERE

WHEN Unisorb pads are placed under your noisy machines, workers in the rooms beneath these machines can perform their tasks more efficiently. The Unisorb pads block off the nerve-racking noise at its source.

Write for our free booklet entitled *"Unisorb In The Industrial Plant"*, which graphically describes the many different vibration insulation installations made with Felters Certified Felt.

THE FELTERS CO., INC.
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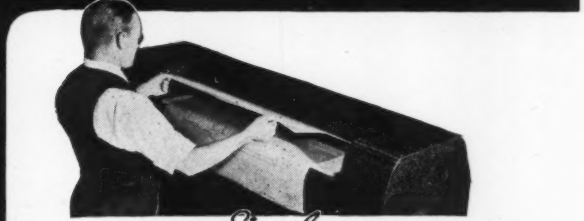
Offices in Principal Cities

MAKE YOUR OWN *Blueprints*

FOR LESS THAN 1¢ PER SQUARE FOOT



REMARKABLE NEW *Simplex* BLUEPRINTER CUTS COST, SAVES TIME — NO EXPENSIVE EQUIPMENT. NO EXPERIENCE NECESSARY! • ACT NOW!

Don't give your money to outside firms for blueprints. With a Simplex Mercury Vapor-Tube Portable Blueprinter you can now make blueprints up to 42" wide (any length) in your own offices at a fraction of regular commercial prices. Makes 250 square feet per hour. Can be used for any of the Special Developing Processes. Requires no carbons or globes. Beautiful black crackle "Weaver" finish. Operates silently. Your office girl can easily operate a Simplex.

FREE TRIAL

FREE TRIAL! Don't take our word for the money-saving advantages of a Simplex! For a limited time only we will ship a regulation, complete Simplex Blueprinter on 30 days' free trial. Satisfaction guaranteed or money refunded. Write today for complete facts about this amazing, money-saving offer.

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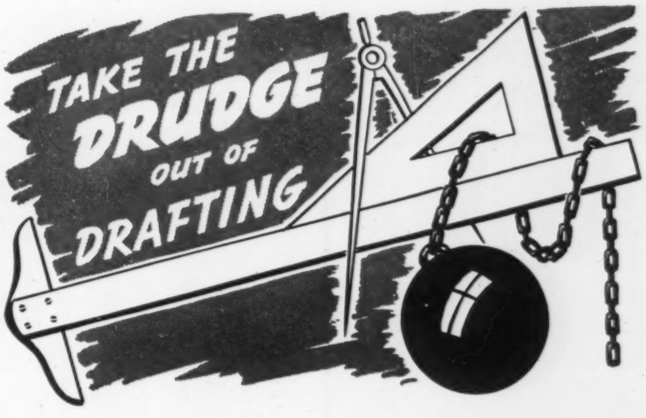
512 NORTH WATER STREET



You can turn many difficult drafting jobs into simple print room operations at a drastic saving with the Ozalid Whiteprint Process.

Why spend weary hours toiling over a drafting board redrawing a tracing when you can get a transparent duplicate of the original drawing with the Ozalid Whiteprint Process in a few minutes?

Lines on a transparent Ozalid print can be easily eliminated by corrector fluid or mechanically by the "block out" method. Since Ozalid transparent materials (paper, cloths, or foils) will take pencil and ink lines, you can get a print from them with changes and additions without redrawing or spoiling the original tracing.

A booklet of dry-developed Ozalid prints and complete information on how to cut drafting time and reduce costs will be sent without obligation. Mail coupon today.

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CORPORATION
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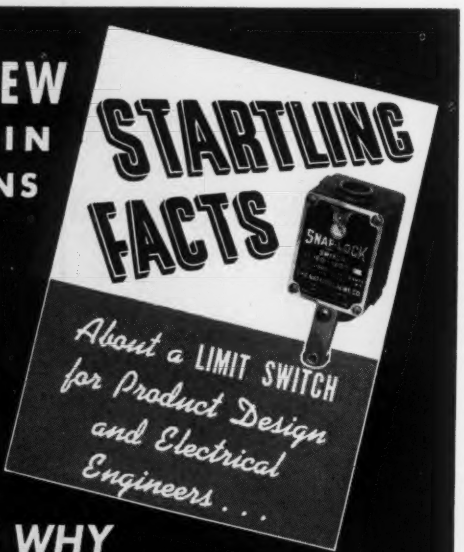
THIS NEW BULLETIN CONTAINS OUR FREE TRIAL OFFER


STARTLING FACTS
SNAP-LOCK
About a LIMIT SWITCH for Product Design and Electrical Engineers . . .

IT TELLS WHY

56 makers of Machine Tools and 89 other industries, tested, OK'd and bought

SNAP-LOCK
TRADE MARK

—the rugged switch for all normal circuits

WRITE FOR YOUR COPY . . . NOW

CHRONOLOG DIVISION OF
THE NATIONAL ACME COMPANY
170 East 131st Street • • Cleveland, Ohio

Gear Specialties

14 to 96 D.P. 14 to 96 D.P.

SPURS
SPIRALS
HELICALS
BEVELS

RACKS
RATCHETS
WORM-GEARING

—such as these, and numerous others, are the logical product of a skilled organization with a deft 'feel' for *precise* work . . . Note the *Combination* Worm-gear, rotating as a Gear on one side and as a Worm on the opposite side.

Made to order only — No stock — No catalog

Gear Specialties
INCORPORATED
CHICAGO

2670 W. MEDILL AVE. PHONE HUMBOLDT 3482

of the conveyor division, to the position of vice presidency. Mr. McKnight, connected with the company since 1926, has served as secretary and sales manager for the Stearns Conveyor Co., a subsidiary, in Cleveland.

*

A change of address of its representative, Northwestern Agencies, has been announced by Ward Leonard Electric Co., Mount Vernon, N. Y. The new offices are located at 2411 First avenue, Seattle, Wash., and include a larger warehouse for electric controls.

*

Associated with the New York office of Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., since 1931, Tomlinson Fort has been transferred to East Pittsburgh as assistant manager of central station sales.

*

Thomas C. Delaney, 215 Montague street, Brooklyn, has been appointed foreign sales manager of Ball & Roller Bearing Co., Danbury, Conn.

*

District office at Richmond, Va., of Allis-Chalmers Mfg., Milwaukee, has been moved to a new location, the Richmond Trust building. The company's Rockford, Ill., office has also been moved, to the Gas-Electric building.

*

Operating facilities of Elmer E. Mills Corp., 812 west Van Buren street, Chicago, injection molders, have been increased over three and one-half times since its inception over two and one-half years ago. In fact, the company has recently doubled its manufacturing space.

*

Work on a new plant at Stamford, Conn., for the Laminated Shim Co. Inc., Long Island City, N. Y., manufacturers of shims, shim stock and small stampings, has begun. It is expected that the plant will be completed early in June of this year.

*

An increase of 100 per cent in manufacturing floor space will be the result of the new building which is being erected by New Jersey Machine Corp., Hoboken, N. J., manufacturers of Motoair pumps for vacuum or pressure. The increased space, it is reported, will be available early in April.

*

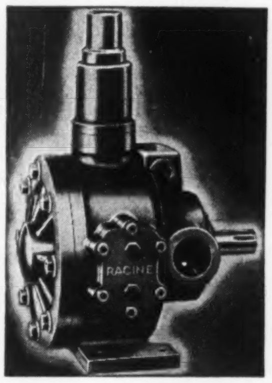
Twenty-five years' healthy growth has been enjoyed by Ohio Gear Co., Cleveland, now celebrating its silver anniversary. According to Harrison Browning, president, the present capacity of the company is more than four times that of a decade ago.

*

Additional appointments of The Timken Roller Bearing Co., Canton, O., include the following: H. C. Sauer has been transferred from Chicago to New York, replacing J. W. Berriman who is ill; L. J. Halderman,

RACINE

Variable Volume Hydraulic Pumps

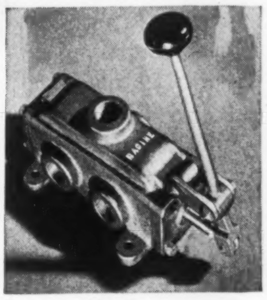


Extremely quiet, smooth performance. A thoroughly proven, efficient pump for pressures up to 1000 lbs. per sq. inch. Capacities 2000—4000—6000 cubic inches per minute.

The Variable Volume feature saves horse-power. Delivers amount of oil actually required. Volume is controlled automatically or manually.

Write for new catalog P-10

Racine Hydraulic Valves



A complete line—manual—pilot or electrically operated. Balanced pistons—Accurately fitted.
For oil-hydraulic installations.

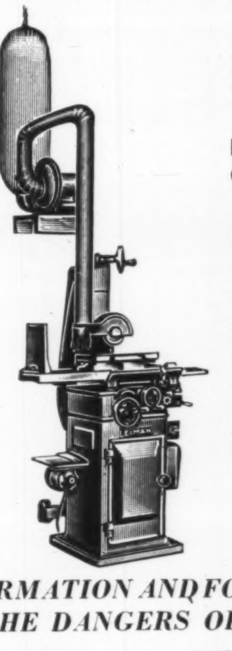
Write for new catalog V-10

RACINE TOOL & MACHINE CO.
1773 State St. Racine, Wis.

LEIMAN BROS. NEW

SURFACE GRINDER DUST COLLECTOR

For Your Grinder of Whatever Make



A Complete Motor-Driven Unit at Small Cost

This small, yet powerful, machine occupies but 11" x 13" space. It consists of a sturdy, powerful suction blower, electrically driven, with piping connections to the surface grinder and to the high grade dust disposal bag.

It can easily be placed on the floor or a shelf on a nearby pillar or wall, out of the way. It can be plugged into any lamp socket.

The strong suction of air draws away all the light metallic and light abrasive dust created when grinding. This highly irritating dust is caught in a bag made of specially treated filter cloth which may be quickly emptied when necessary.

Don't Breathe Grinding Dust!

"The direct cause of silicosis is the inhalation of minute particles of silica dust. While the type of pulmonary lesion depends on the particular dust inhaled, the underlying pathological principle is the same in all forms of the disease, viz., an ultimate fibrosis and replacement of the elastic lung tissue by a hard unyielding fibrous tissue."

SILICOSIS IS INCURABLE!

GET FREE INFORMATION AND FOLDER No. PIC ABOUT THE DANGERS OF DUST

LEIMAN BROS., 23(PIC) WALKER ST. NEW YORK CITY

MAKERS OF GOOD MACHINERY FOR 50 YEARS

BREAKDOWN
CORROSION
FATIGUE
WEAR
DO THESE DEVILS OF DESTRUCTION PLAGUE YOU?

AMPCO METAL

IS OFTEN THE ANSWER

If you require a non-ferrous alloy that provides the utmost in wear resistance—tensile strength—corrosion resistance . . . then you have a job for Ampco Metal.

Time and again—for hundreds of manufacturers, Ampco Metal has proved its value in a wide variety of applications, ranging from cams, shifters, nuts, gears, bushings and bearings, to forming and drawing dies and acid resistant equipment. Time and again it has proved its ability to outlast other alloys in difficult services—that it can actually outwear hardened steel. In some one of its six grades Ampco Metal can probably solve a problem for you—why not check with us.

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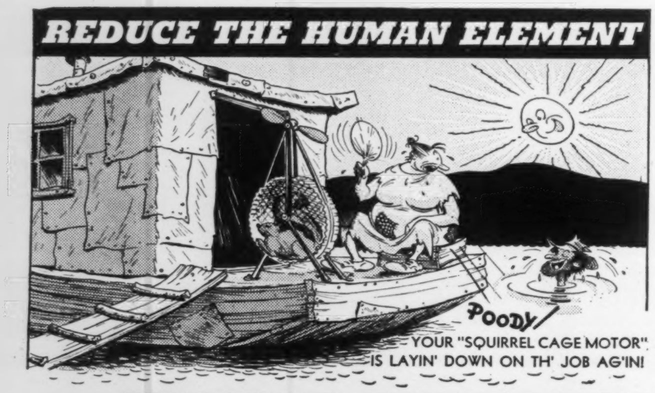
Dept. MD-3 Milwaukee, Wisconsin

"The Metal without an Equal"

AMPCO METAL

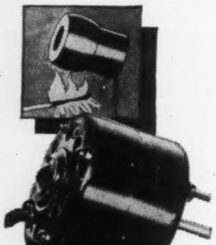
. . distinguished by this mark.

REDUCE THE HUMAN ELEMENT


POODY!
YOUR "SQUIRREL CAGE MOTOR"
IS LAYIN' DOWN ON TH' JOB AG'IN!

WITH VICTOR MOTORS!

To be lazy is to be human. Forget to oil or oil too much the ordinary motor and it becomes (*1*) Smoke Dreams; (*2*) Gone With the Wind; (*3*) Oh, Johnny. Victor Motors compensate for the human element . . . with specially compounded oversize bearings of the self-lubricating type. They're not the ordinary so-called oilless, self-aligning kind. Victor bearings have proper: (*1*) bearing area, (*2*) oil impregnation and type of oil, (*3*) broaching (proper shaft-bearing clearance), (*4*) finish of bore and (*5*) special mountings to assure rigidity and alignment. Victor Motors give the nearest thing to carefree performance this side of heaven. *Sizes from 1/200 up to 1/10 h.p.* Write for illustrated bulletin . . . and tell us, please, what's on your mind, motorwisely speaking. *Write Dept.* M-301



VICTOR ELECTRIC PRODUCTS, Inc.
2950 Robertson Road . . . Cincinnati, Ohio

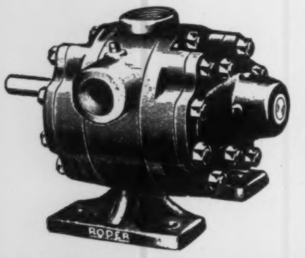
Smooth PUMPERS

The simplicity and perfect balance of Ropers make them exceptionally smooth pumpers. When you see Roper Pumps in action and appraise their quietness and effortless power you will probably say . . . that's the kind of pumping efficiency I want.

The perfect balance in Ropers has been attained by long building experience (83 years) and highly developed skill in producing precise uniformity. The smoothness with which Ropers operate accounts for their lower operating and maintenance costs.

Whatever your pumping requirements may be . . . get the facts from Roper.

Write for Bulletin R4MD



ROPER
Rotary PUMPS
DEPENDABLE SINCE 1857

GEO. D. ROPER CORP., ROCKFORD, ILL.

formerly manager of the company's Kansas City branch, replaces Mr. Sauer in Chicago; and F. A. Weisenberger assumes the managerial responsibilities of the Kansas City branch, being promoted from the Pittsburgh sales force.

*

Connecticut Plastic Products Co. has been organized by James P. Sullivan, formerly with Waterbury Button Co. The new company, located at 124 North Elm street, Waterbury, Conn., at present is equipped for injection molding only.

*

An up-to-date research laboratory for powder metallurgy is being equipped in Yonkers, N. Y., by American Electro Metal Corp., Lewiston, Me.

*

Recent election of Harold Swanton as vice president of Precision Bearings Inc., Los Angeles, has been announced by the company. Mr. Swanton succeeds Norman Bell, resigned.

*

Joseph T. Ryerson & Son Inc. has its new all-steel building in Chicago near completion. The new building will considerably increase the company's space, much of which will be used for storing hot rolled steel bars, shapes and plates.

*

Resigning as general manager and chief engineer of Commonwealth Plastics Co., Leominster, Mass., William M. Lester has organized the Pyro Plastics Co., Westfield, N. J., which will engage in custom injection molding. Mr. Lester is general manager of the new company.

*

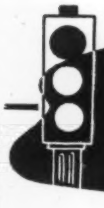
Appointment of N. E. MacEwan as sales representative in the Detroit area for Stolpher Steel Products Corp., Milwaukee, stampings producers, has been made.

*

Organization of the Magnetic Engineering & Mfg. Co., with home office and plant at Clifton, N. J., has recently been announced to design and build a complete line of magnetic chucks, clutches, magnetic separators and special magnetic equipment. J. J. Ferris is president, J. L. Hope, vice president, and F. E. Ferris, secretary and treasurer. J. J. Ferris had been general manager of Dings Co. with which he was affiliated for the past 11 years.

*

Jones & Laughlin Steel Corp., Pittsburgh, has made the following appointments: William K. Breeze, since March, 1938, district sales manager at the company's New York office, as Pacific coast manager with supervision over the district offices at Los Angeles, San Francisco and Seattle; John B. DeWolf as district sales manager in New York; and Herbert B. Spackman as district sales manager in Philadelphia.



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use **IDEAL** *Wire-Nuts*

You'll slash material costs the moment you specify these inexpensive, solderless, tapeless Wire Connectors. *Ideal* "Wire-Nuts" replace terminal blocks, binding posts, solder and tape joints, etc.

These wire joints increase the value and cut the cost of new equipment, and they're better electrically—stronger mechanically.

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Electrical Products Division

IDEAL COMMUTATOR DRESSER CO.
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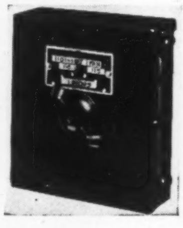
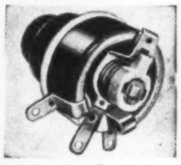
Ward Leonard Motor Speed Regulators include everything from the small ring type rheostats for window ventilators to the heaviest industrial blower controls. Well planned arrangements provide circulation of air around resistance elements to dissipate the generated heat. Ward Leonard Speed Regulators will therefore operate continuously, at any speed setting, in the hottest weather without overheating, and, if it's automatic control for air conditioning you will be interested in Ward Leonard Multi-Speed Motor Starters.



Speed Regulator 1101



Ring Type Rheostat 1105

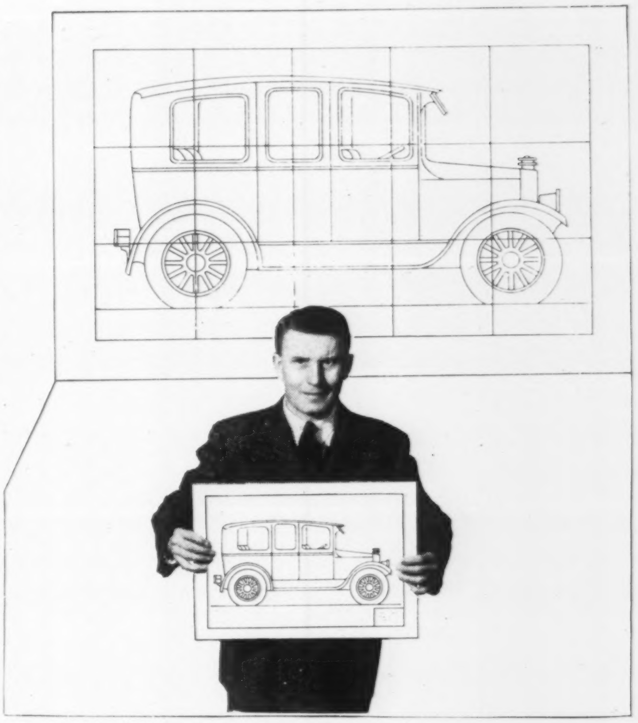
Send for bulletins of interest.

BULLETIN 1101 describes Ward Leonard Speed Regulator, ventilated and enclosed types 1/20 to 1/3 H.P.

BULLETIN 1105 describes Ward Leonard Vitrohm Ring Type Rheostats 1½", 2¼", 3" and 4" diameters for 30, 50, 100 and 150 watts.

BULLETIN 4061 describes Multi-Speed Starters

WARD LEONARD
ELECTRIC COMPANY
45 South Street, Mount Vernon, N. Y.
ELECTRIC CONTROL DEVICES SINCE 1892



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NEW MACHINES—

And the Companies Behind Them

(For illustrations of other outstanding machinery see Pages 54-55)

Agricultural

Leaf pulverizing and dispersing attachment for mower, Standard Mfg. & Sales Corp., Lebanon, Ind.

Variable weight tandem roller*, Galion Iron Works & Mfg. Co., Galion, O.

Automotive

Diesel engine, Caterpillar Tractor Co., Peoria, Ill.

Bakery

Low pressure 4-pocket divider, Century Machine Co., Cincinnati.

Bread slicer, Micro-Westco Inc., Bettendorf, Ia.

High speed mixer, Read Machinery Co. Inc., York, Pa.

Mixer, Champion Machinery Co., Joliet, Ill.

Boating

Motors, Evinrude Motors, Milwaukee.

Business

Scale, The Exact Weight Scale Co., Columbus, O.

Hair dryer*, The Nestle-LeMur Co., New York.

Recorder*, William L. Wolf, New York.

Display

Paper cutout machine*, International Register Co., Chicago.

Domestic

Electric washer, Crosley Corp., Cincinnati.

Automatic washer, rinser and damp dryer, Blackstone Mfg. Co., Jamestown, N. Y.

Radio*, Kadette Radio Corp., Ann Arbor, Mich.

Industrial

Lubricated air compressors, Quincy Compressor Co., Quincy, Ill.

Multipurpose portable tool, H & H Research Co., Detroit.

Gas absorbers, The Patterson Foundry & Machine Co., E. Liverpool, O.

Compressor*, Gardner-Denver Co., Quincy, Ill.

Marine

Amphibian tractor*, Donald Roebling, Clearwater, Fla.

Metalworking

Cut-off machine, Delta Mfg. Co., Milwaukee.

Electric hammer, Independent Pneumatic Tool Co., Chicago.

Straightening press, Denison Engineering Co., Columbus, O.

Horizontal threading and tapping machine, Rickert-Shafer Co., Erie, Pa.

Power squaring shears, Niagara Machine & Tool Works, Buffalo, N. Y.

Bending press, The Cleveland Crane & Engineering Co., Wickliffe, O.

Cylindrical grinding machine, Farrel-Birmingham Co. Inc., Ansonia, Conn.

Die casting machine, Phoenix Machine Co., Cleveland.

Double crank press, Zeh & Hehnemann Co., Newark, N. J.

Hydraulic press, Greenerd Arbor Press Co., Nashua, N. H.

Semiautomatic threading machine, L. J. Kauffman Mfg. Co., Manitowoc, Wis.

Hydraulic grinding machine*, Cincinnati Grinders Inc, Cincinnati.

Office

Electrified bookkeeping machine*, Remington Rand Inc., Buffalo, N. Y.

Dictating machine*, Dictaphone Corp., Bridgeport, Conn.

Road

Finishing machine, Flexible Road Joint Machine Co., Warren, O.

Heavy duty rooter, R. G. Le Tourneau Inc., Peoria, Ill.

Scraper, Gar Wood Industries Inc., Detroit.

Truck mixer, Concrete Transport Mixer Co., St. Louis.

Combination block machine, Mills Mfg. Co., Jackson, Mich.

Diesel powered shovel, The Byers Machine Co., Ravenna, O.

Remixing concrete spreader, Jaeger Machine Co., Columbus, O.

Woodworking

Saw bench, Oliver Machinery Co., Grand Rapids, Mich.

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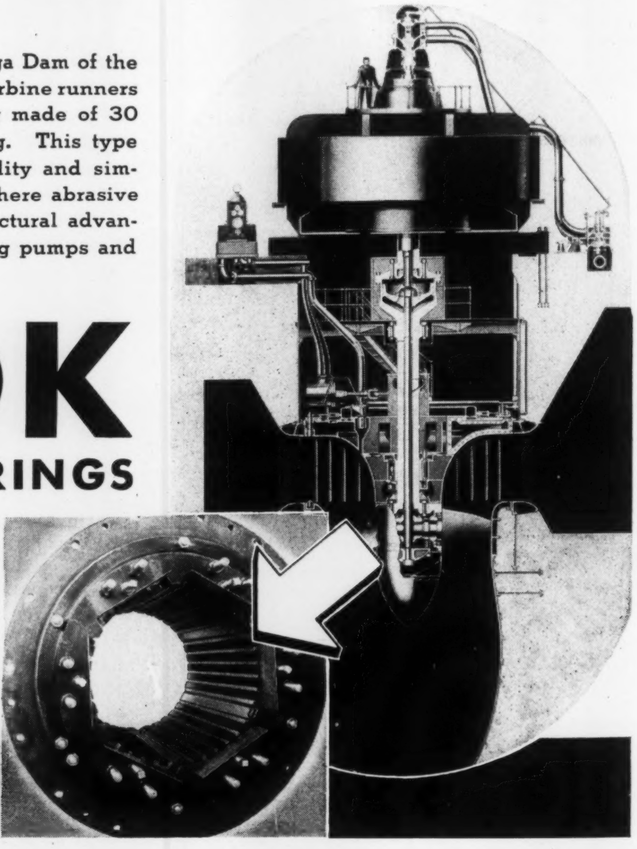
* *Illustrated in pictorial center spread, Pages 54-55.*



This Bearing is "*Oiled*" with *Water*

In this Baldwin Southwark installation, located at Chickamauga Dam of the T. V. A., a shaft, 37" in diameter, connecting the I. P. Morris turbine runners with the generators, revolves in an adjustable steady bearing made of 30 machined bars of Laminated INSUROK, each 67 inches long. This type of bearing, lubricated with water only, has greater accessibility and simplicity, and improved operation over other types, especially where abrasive material is present in the water. It also effects important structural advantages and economies, among them the elimination of lubricating pumps and water drainage pumps usually required for oil bearings.

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LAMINATED PLASTIC BEARINGS

Under difficult operating conditions, and where oil and grease lubrication are a hazard, INSUROK Bearings perform outstandingly. They are tough, durable and long lasting. They resist the destructive action of most greases, oils, acids, solvents and reagents. Consult Richardson engineers about your bearing problems. No cost or obligation involved. Address office nearest you.

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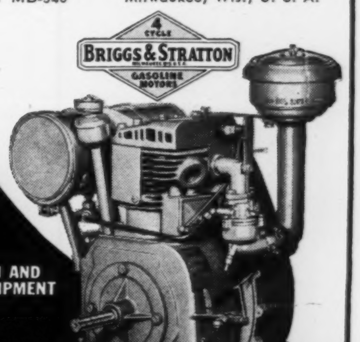

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